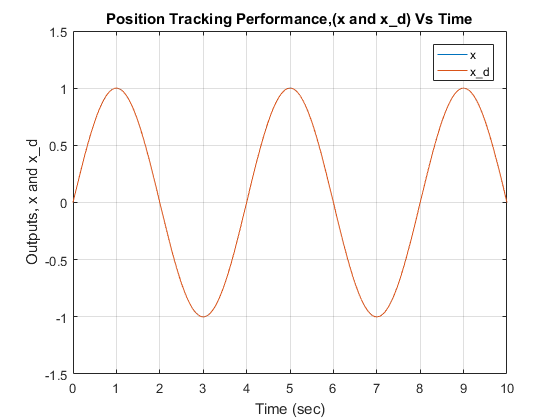
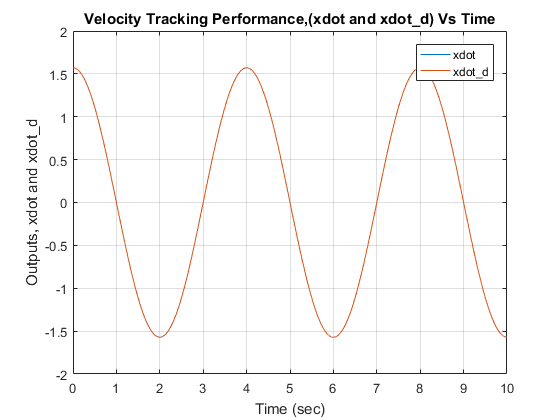
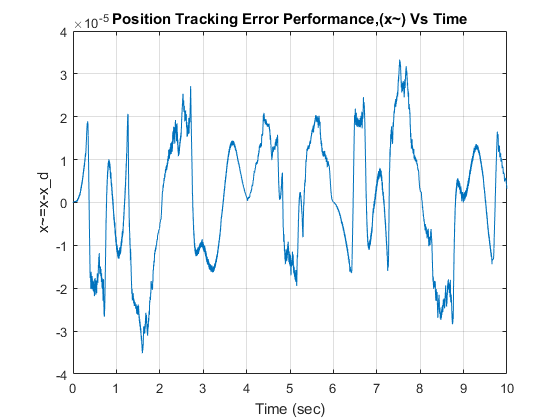
**PLOTS: SIGNUM FUNCTION**



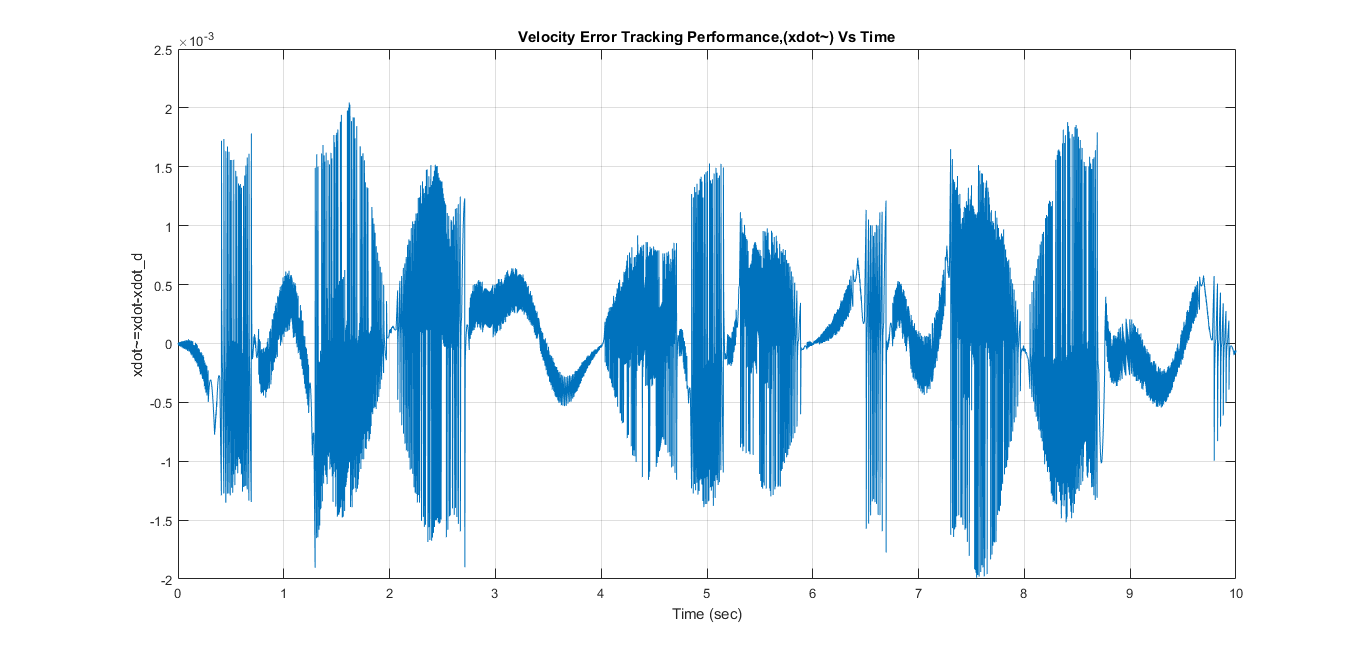
**Figure 1:** Position Tracking Performance



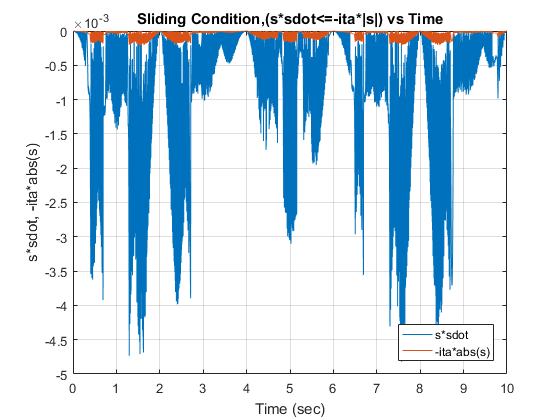
**Figure 2:** Velocity Tracking Performance



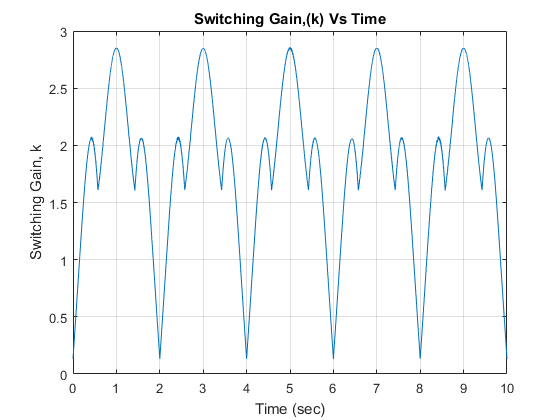
**Figure 3:** Position Tracking Error Performance

****

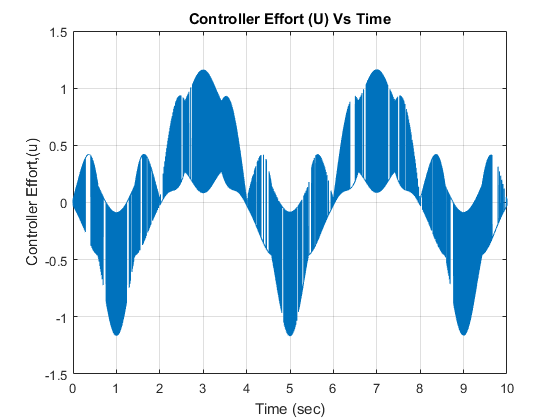
**Figure 4:** Velocity Tracking Error Performance



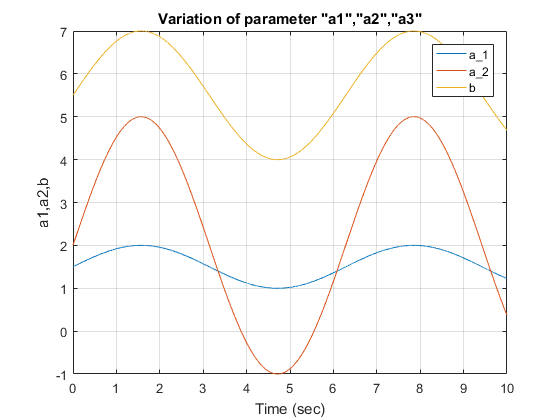
**Figure 5:** Sliding Condition



**Figure 6:** Switching Gain

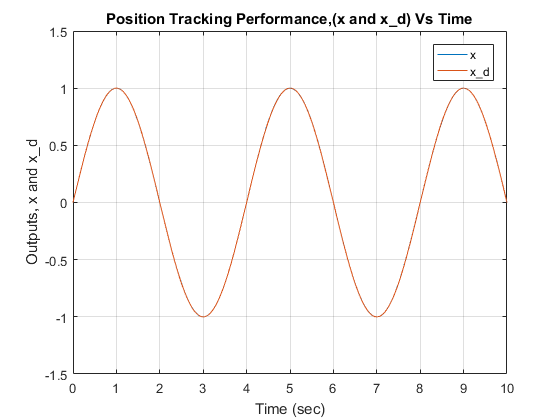


**Figure 7:** Controller Effort

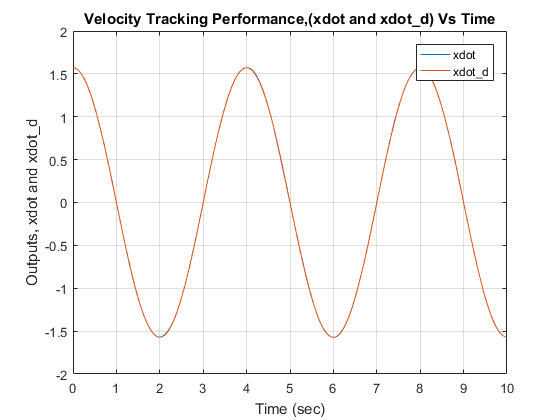


**Figure 8:** Variation of System Parameters, α1, α2, b

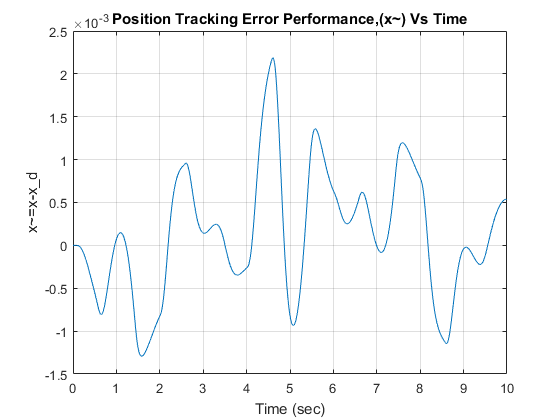
**PLOTS: SATURATION FUNCTION**

****

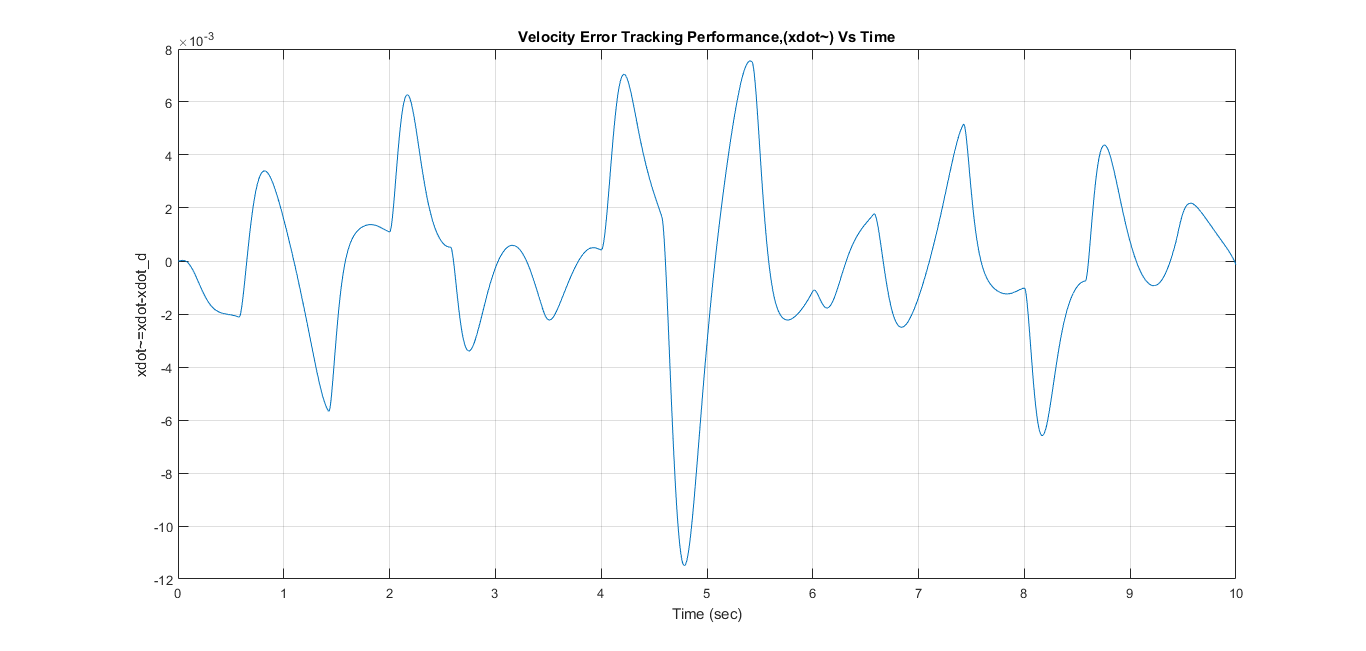
**Figure 9:** Position Tracking Performance

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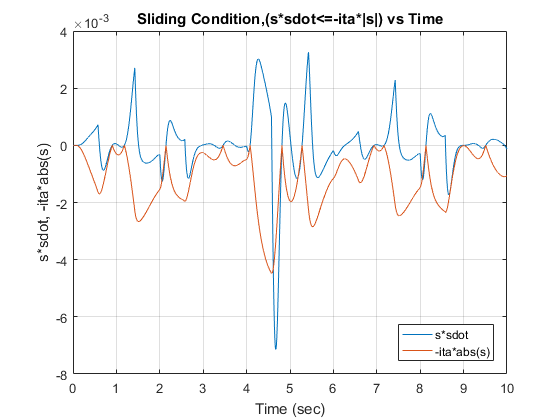
**Figure 10:** Velocity Tracking Performance

****

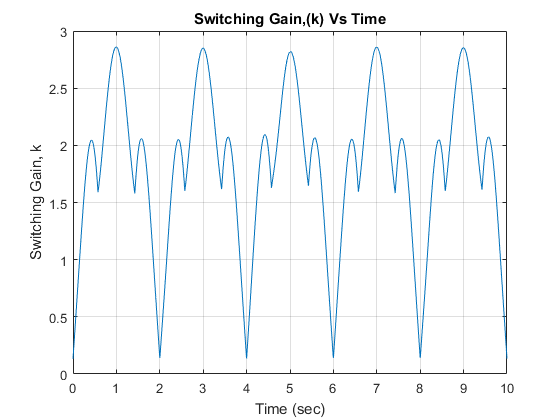
**Figure 11:** Position Tracking Error Performance

****

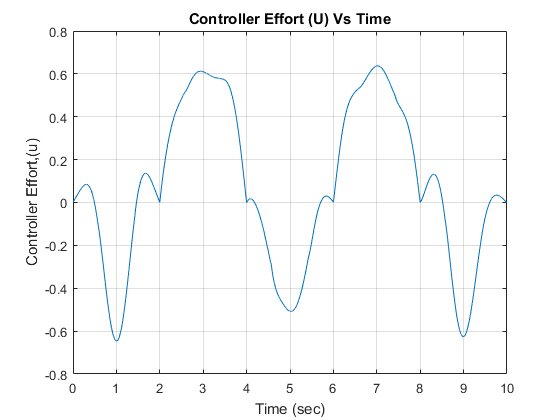
**Figure 12:** Velocity Tracking Error Performance

****

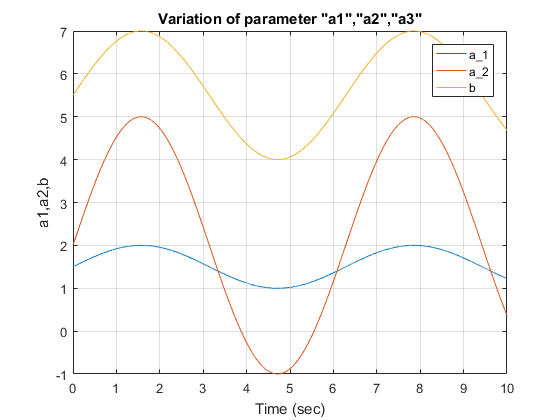
**Figure 13:** Sliding Condition



**Figure 14:** Switching Gain

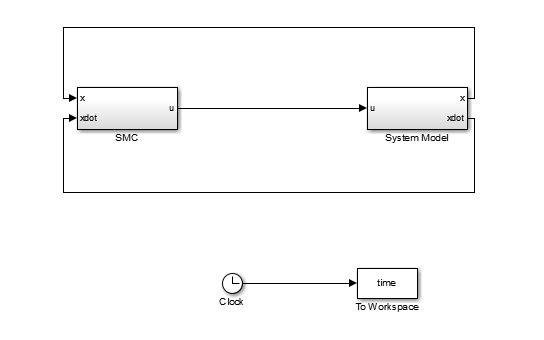


**Figure 15:** Controller Effort

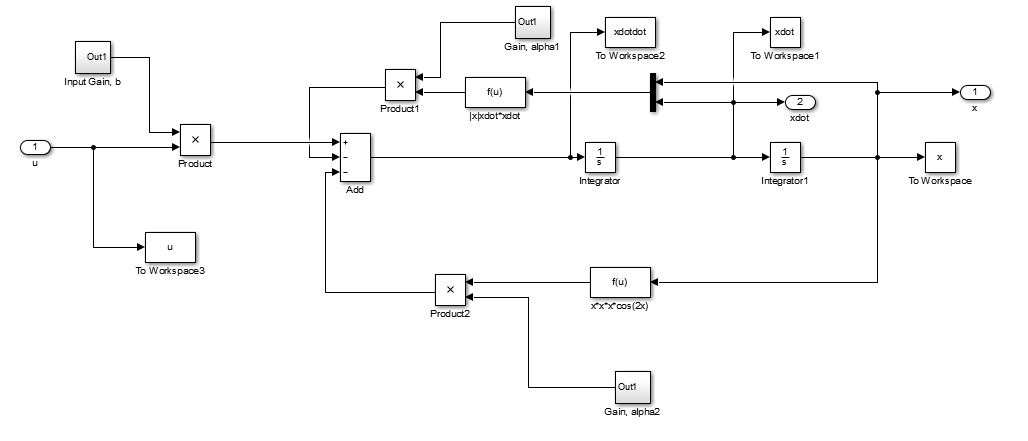


**Figure 16:** Variation of System Parameters, α1, α2, b

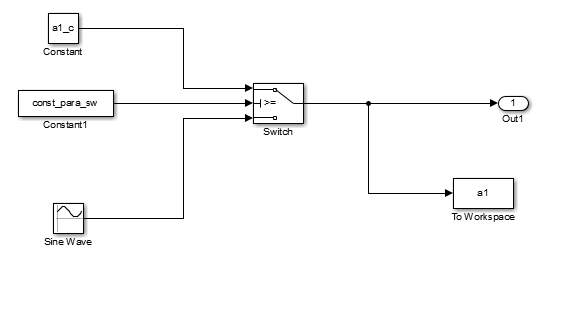
**SIMULINK MODELS**

****

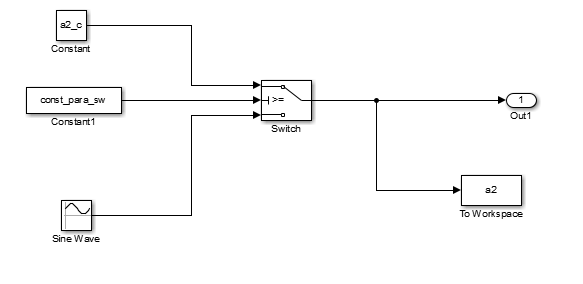
**Figure 17:** Main Block Diagram

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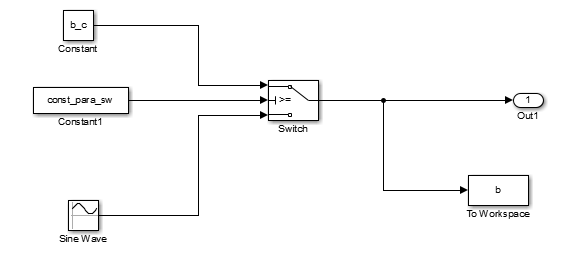
**Figure 18:** System Model



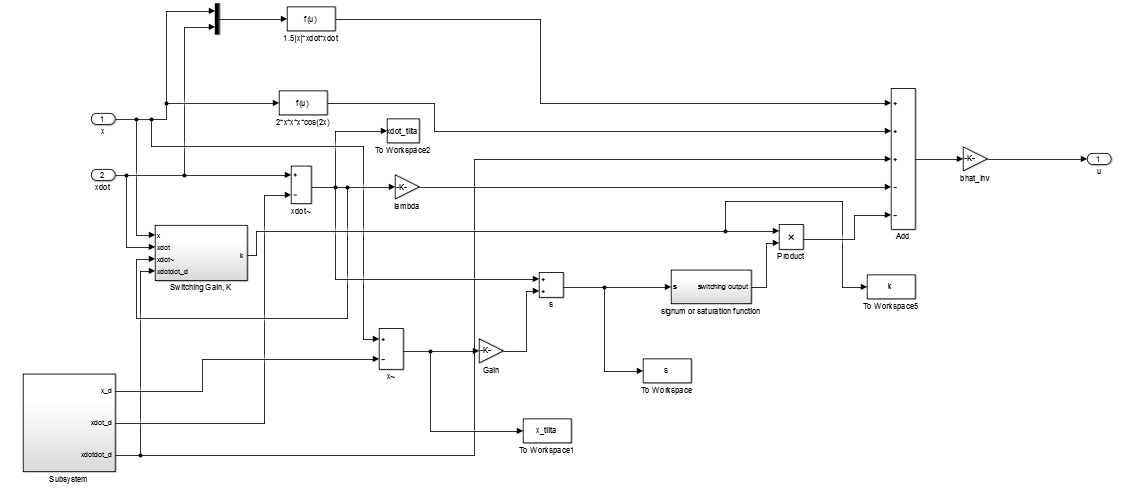
**Figure 19:** System Parameterα1

****

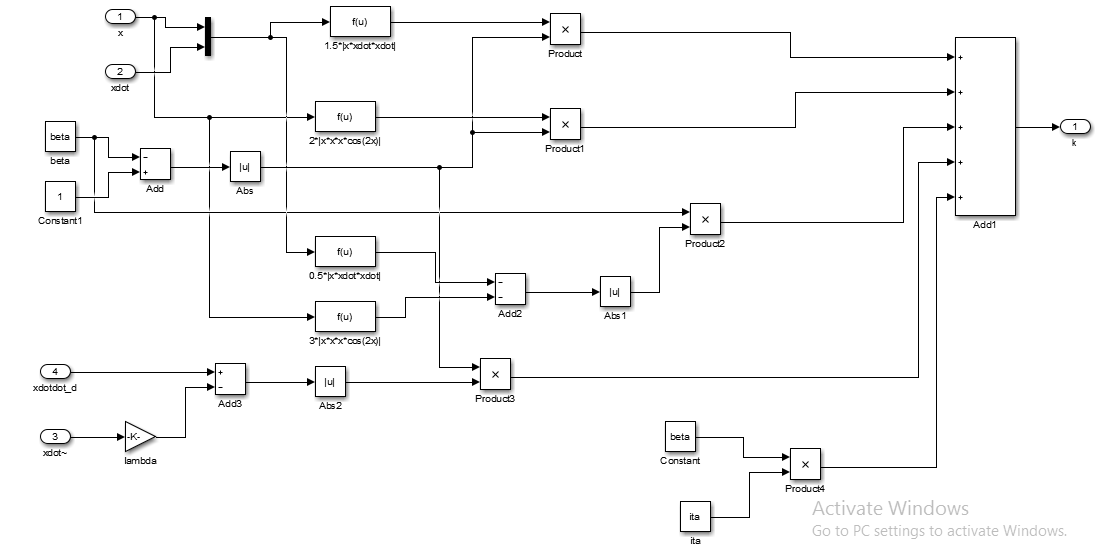
**Figure 20:** System Parameter α2



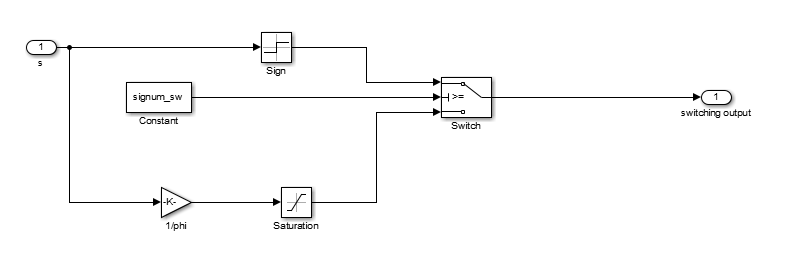
**Figure 21:** System Parameter b



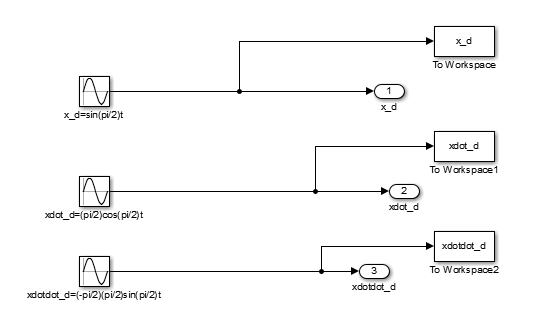
**Figure 22:** SMC Block



**Figure 23:** Switching Gain Block



**Figure 24:** Signum / Saturation Function Switching Block



**Figure 25:** Desired Tracking Function Block

**MATLAB CODE**

%% Computer Project 4

%% Coded By K S Adarsh Raj

clear all,clc;

%% Switch between constant or varying system parameters

% const\_parm\_sw=input([1]:constant, [0]:vary);

const\_para\_sw=0;

if( isempty(const\_para\_sw) )

const\_para\_sw=0;

end

%% Switch betwewn Signum or Saturation Function

% signum\_sw=input([1]:signum, [0]:saturation);

signum\_sw=1;

if( isempty(signum\_sw) )

signum\_sw=1;

end

%% Define the Constant System Model Parameters

a1\_c=1.5;

a2\_c=2;

b\_c=5.5;

%% Define Initial Condtions for x and xdot

x0=0;

xdot0=pi/2;

%% Define the SMC gains

lambda=20;

ita=0.1;

phi=0.1;

%% Define the upper and lower bounds for a1 and b

a1\_upp=2;

a1\_low=1;

b\_upp=7;

b\_low=4;

%% Define a1hat and bhat

a1hat=sqrt(a1\_upp\*a1\_low);

bhat=sqrt(b\_upp\*b\_low);

%% Define inverse of a1hat and bhat

a1hat\_inv=1/a1hat;

bhat\_inv=1/bhat;

%% Define alpha1 and beta

alpha1=sqrt(a1\_upp/a1\_low);

beta=sqrt(b\_upp/b\_low);

%% Run the simulation

sim('Project4');

%% Calculate sdot

sdot=(xdotdot-xdotdot\_d)+lambda\*(xdot-xdot\_d);

%% Plot the Required Results

%Plot of x and x\_d

figure(1),plot(time,x,time,x\_d)

grid on

title('Position Tracking Performance,(x and x\\_d) Vs Time')

xlabel('Time (sec)')

ylabel('Outputs, x and x\\_d')

legend('x','x\\_d')

%Plot of xdot and xdot\_d

figure(2),plot(time,xdot,time,xdot\_d)

grid on

title('Velocity Tracking Performance,(xdot and xdot\\_d) Vs Time')

xlabel('Time (sec)')

ylabel('Outputs, xdot and xdot\\_d')

legend('xdot','xdot\\_d')

%Plot of x~

figure(3),plot(time,x\_tilta)

grid on

title('Position Tracking Error Performance,(x~) Vs Time')

xlabel('Time (sec)')

ylabel('x~=x-x\\_d')

%Plot of xdot~

figure(4),plot(time,xdot\_tilta)

grid on

title('Velocity Error Tracking Performance,(xdot~) Vs Time')

xlabel('Time (sec)')

ylabel('xdot~=xdot-xdot\\_d')

%Plot of Sliding Condition

figure(5),plot(time,s.\*sdot,time,-ita\*abs(s))

grid on

title('Sliding Condition,(s\*sdot<=-ita\*|s|) vs Time')

xlabel('Time (sec)')

ylabel('s\*sdot, -ita\*abs(s)')

legend('s\*sdot','-ita\*abs(s)','Location','SouthEast')

%Plot of Switching Gain

figure(6),plot(time,k)

grid on

title('Switching Gain,(k) Vs Time')

xlabel('Time (sec)')

ylabel('Switching Gain, k')

%Plot of Controller Effort

figure(7),plot(time,u)

grid on

title('Controller Effort (U) Vs Time')

xlabel('Time (sec)')

ylabel('Controller Effort,(u)')

%Plot of Varying Parameters

figure(8),plot(time,a1,time,a2,time,b)

grid on

title('Variation of parameter "a1","a2","a3"')

xlabel('Time (sec)')

ylabel('a1,a2,b')

legend('a\\_1','a\\_2','b')