%state feedback control

function dx = ode\_45\_test(t,x)

R= 200;

L= 0.560;

Cap= 0.001;

d= 0.5;

A= [(-1)/(R\*Cap) 1/Cap; (-1)/L 0];

B= [0; d/L];

C= [1 0];

D= 10;

p=[-90 -10];

K= place(A,B,p);

%{

%step input

if t >= 2

u=25;

else

u=0;

end

%}

%{

%impulse input

if t >= 2 && t< 2.1

u= 1;

else

u= 0;

end

%}

% sine input

u=sin(t);

dx = (A-B\*K)\*x + B\*u;

y= C\*x ;

end

%state feedback testbench

tspan = 0:0.01:10;

t=tspan;

iniCon = [1;0];

[t, y] = ode45(@ode\_45\_test, tspan, iniCon);

plot(t,y(:,1));

hold on;

plot(t,sin(t));

grid

%state feedback with integral control

function dx = ode\_45\_stateintegral(t,x)

R= 200;

L= 0.560;

Cap= 0.001;

d= 0.5;

A= [(-1)/(R\*Cap) 1/Cap; (-1)/L 0];

B= [0; d/L];

C= [1 0];

D= 10;

Ahat=[A zeros(2,1); -C 0];

Bhat=[B;0];

Chat=[C 0];

p=[-90 -10 -0.001];

K= place(Ahat,Bhat,p);

%step input

if t <= 2

u=0;

else

u=1;

end

%{

%impulse input

if t >= 2 && t< 2.2

u= 1;

else

u= 0;

end

%}

% sine input

%u=sin(t);

dx = (Ahat-Bhat\*K)\*x + Bhat\*u;

y= Chat\*x ;

end

%state feedback with integral test bench

tspan = 0:0.01:10;

t=tspan;

iniCon = [1;0;0];

[t, y] = ode45(@ode\_45\_stateintegral, tspan, iniCon);

plot(t,y(:,1));

hold on;

%plot(t,sin(t));

grid

%state observer

function dx = ode\_45\_observer(t,x)

R= 200;

L= 0.560;

Cap= 0.001;

d= 0.5;

A= [(-1)/(R\*Cap) 1/Cap; (-1)/L 0];

B= [0; d/L];

C= [1 0];

D= 10;

p=[-7 -3];

L= place(A',C',p)';

%{

%step input

if t >= 2

u=1;

else

u=0;

end

%}

%impulse input

if t >= 2 && t< 2.2

u= 1;

else

u= 0;

end

% sine input

%u=sin(t);

dx = (A-L\*C)\*x + B\*u;

y= C\*x ;

end

%state observer testbench

tspan = 0:0.01:10;

t=tspan;

iniCon = [1;0];

[t, y] = ode45(@ode\_45\_observer, tspan, iniCon);

plot(t,y(:,1));

hold on;

%plot(t,sin(t));

grid

%state observer with integral control

function dx = observer\_with\_integral\_ode45(t,x)

R= 200;

L= 0.560;

Cap= 0.001;

d= 0.5;

A= [(-1)/(R\*Cap) 1/Cap; (-1)/L 0];

B= [0; d/L];

C= [1 0];

D=0 ;

Ahat=[A zeros(2,1); -C 0];

Bhat=[B;0];

Chat=[C 0];

pf=[-90 -10 1];

po=[-3 -7];

K= place(Ahat,Bhat,pf);

L= place(A',C',po)';

Kh= [K(1) K(2)];

Ki= K(3);

%step input

if t <= 4

u=0;

else

u=2;

end

%{

%impulse input

if t >= 2 && t< 2.2

u= 1;

else

u= 0;

end

%}

% sine input

%u=sin(t);

A\_closed=[A -B\*Kh B\*Ki;L\*C A-B\*Kh-L\*C B\*Ki;-C zeros(1,3)];

B\_closed=[0;0;0;0;1];

C\_closed=[C 0 0 0];

D\_closed=0;

dx = A\_closed\*x + B\_closed\*u;

y= C\_closed\*x ;

end

%state observer with integral testbench

tspan = 0:0.01:10;

t=tspan;

iniCon = [2;0;0;0;0];

[t, y] = ode45(@observer\_with\_integral\_ode45, tspan, iniCon);

plot(t,y(:,1));

hold on;

%plot(t,sin(t));

grid

%LQR control

function dx = ode\_45\_LQR(t,x)

R= 200;

L= 0.560;

Cap= 0.001;

d= 0.5;

A= [(-1)/(R\*Cap) 1/Cap; (-1)/L 0];

B= [0; d/L];

C= [1 0];

D= 0;

R=1;

Q=[1 0;0 1];

K= lqr(A,B,Q,R);

%{

%step input

if t >= 2

u=2;

else

u=0;

end

%}

%{

%impulse input

if t >= 2 && t< 2.1

u= 1;

else

u= 0;

end

%}

% sine input

u=sin(t);

dx = (A-B\*K)\*x + B\*u;

y= C\*x ;

end

%LQR control testbench

tspan = 0:0.01:10;

t=tspan;

iniCon = [1;0];

[t, y] = ode45(@ode\_45\_LQR, tspan, iniCon);

plot(t,y(:,1));

hold on;

plot(t,sin(t));

grid

%LQR with integral control

function dx = ode\_45\_LQR\_integral(t,x)

R= 200;

L= 0.560;

Cap= 0.001;

d= 0.5;

A= [(-1)/(R\*Cap) 1/Cap; (-1)/L 0];

B= [0; d/L];

C= [1 0];

D= 0;

R=1000;

Q=[1 0 0;0 1 0;0 0 1];

Ahat=[A zeros(2,1); -C 0];

Bhat=[B;0];

Chat=[C 0];

K= lqr(Ahat,Bhat,Q,R);

%step input

if t >= 2

u=2;

else

u=0;

end

%{

%impulse input

if t >= 2 && t< 2.2

u= 1;

else

u= 0;

end

%}

% sine input

%u=sin(t);

dx = (Ahat-Bhat\*K)\*x + Bhat\*u;

y= Chat\*x ;

end

%LQR with integral test bench

tspan = 0:0.01:5;

t=tspan;

iniCon = [1;0;0];

[t, y] = ode45(@ode\_45\_LQR\_integral, tspan, iniCon);

plot(t,y(:,1));

hold on;

%plot(t,sin(t));

Grid

%PID control

function dx = ode\_45\_PID(t,x)

R= 200;

L= 0.560;

Cap= 0.001;

d= 0.5;

A= [(-1)/(R\*Cap) 1/Cap; (-1)/L 0];

B= [0; d/L];

C= [1 0];

D= 0;

[m,n]=ss2tf(A,B,C,D);

open=tf(m,n);

y=pid(3,6,7);

closed=feedback(y\*open,1);

[N\_closed,M\_closed]=tfdata(closed,'v');

[A\_closed,B\_closed,C\_closed,D\_closed]=tf2ss(N\_closed,M\_closed);

%{

%step input

if t >= 2

u=2;

else

u=0;

end

%}

%impulse input

if t >= 2 && t< 2.1

u= 1;

else

u= 0;

end

% sine input

%u=sin(t);

dx = A\_closed\*x + B\_closed\*u;

y= C\_closed\*x ;

end

%PID control test bench

tspan = 0:0.01:10;

t=tspan;

iniCon = [1;0;0];

[t, y] = ode45(@ode\_45\_PID,tspan,iniCon);

plot(t,y(:,1));

hold on;

plot(t,sin(t));

grid