```
clear all
% Run file for backstepping controller...

tspan=[0 8]
x0=[2 3]
[t,x]=ode45('sys',tspan,x0);

% Calculating the control...

for i=1:length(t),
    u(i)=contr(x(i,:));
end

figure(1)
plot(x(:,1),x(:,2),'k-');
xlabel('x1')
ylabel('x2')
title('phase portrait')

figure(2)
plot(t,x(:,1),'k-',t,x(:,2),'k--')
xlabel('time,sec')
ylabel('x1 and x2 (dashed)')
title('time response')

figure(3)
plot(t,u)
xlabel('time, sec')
ylabel('control, u')
title('Control Output')

function xdot=sys(t,x)
% Function file for back stepping controller example...
% ME 7200 - Spring 2003

u=contr(x);

xdot(1)=-x(1)^2-x(1)^3+x(2);
xdot(2)=u;
xdot=xdot';

function u=contr(x)
% Backstepping controller...
z=x(2)+x(1)+x(1)^2;
u=-x(1)-(1+2*x(1))*(-x(1)-x(1)^3+z)-z;
```


phase portrait

time response

Control Output