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```

M=1000;
m1=100;
m2=100;
l1=20;
l2=10;
g=9.81;
I = [1;1;5;0;5;0];
%{
Try the following sets of values values
---> Initial COndition: I = [0;0;0;0;0;0]
---> I = [0;0;5;0;0;0]; t = 1:0.001:10;
---> I = [1;0;5;0;5;0]; t = 1:0.0001:10;
---> I = [1;0;5;0;5;0]; t = 1:0.001:10;
---> I = [0;0;5;0;10;0]; t = 1:0.001:10;
I = [1;1;5;0;5;0]; t = 1:0.0001:10;
%}
t = 1:0.0001:10;
[t,x] = ode45(@nlsys_solve,t,I);
plot(t,x,'linewidth',1);
title('response of the non-linear system');

%%Function Definition
function nlsys= nlsys_solve(t,x)
M=1000;
m1=100;
m2=100;
l1=20;
l2=10;
g=9.81;

A_f=[0 1 0 0 0 0;0 0 (-m1*g)/M 0 (-m2*g)/M 0;0 0 0 1 0 0;0 0 -(g/
l1)*((m1+M)/M) 0 (-m2*g)/M*l1 0;0 0 0 0 0 1;0 0 (-m1*g)/M*l2 0 -(g/
l2)*((m2+M)/M) 0];
B_f=[0;1/M;0;1/(M*l1);0;1/(M*l2)];
eigs(A_f);
C = [1,0,0,0,0,0];
%C = diag([1 1 1 1 1 1]);
%C1 = [1,0,0,0,0,0];
%D = [0;0;0;0;0;0];
D = [0];

Q = [12000000000 0 0 0 0 0;0 2 0 0 0 0;0 0 110000000000 0 0 0 ; 0 0 0
0.1 0 0;0 0 0 0 140000000000 0;0 0 0 0 0 1];
R = 10;
eig_Q = eigs(Q);
N = [0;0;0;0;0;0];

[K2,S2,e2] = lqr(A_f+eye(size(A_f)),B_f,Q,R,N);

F = -K2*x;

nlsys = zeros(6,1);

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nlsys(1)= x(2);

nlsys(2)= ((F) - m1*g*sind(x(3))*cosd(x(3)) - m1*l1*x(4)^2*sind(x(3))
- m2*l2*x(6)^2*sind(x(5)) - m2*g*sind(x(5))*cosd(x(5)))/(M
+m1*(sind(x(3)))^2+ m2*(sind(x(5)))^2);

nlsys(3)= x(4);

nlsys(4)= (((F) - m1*g*sind(x(3))*cosd(x(3)) - m1*l1*x(4)^2*sind(x(3))
- m2*l2*x(6)^2*sind(x(5)) - m2*g*sind(x(5))*cosd(x(5)))*cosd(x(3))/
(M+m1*(sind(x(3)))^2+ m2*(sind(x(5)))^2)*l1)-(g*sind(x(3)))/l1);

nlsys(5)= x(6);

nlsys(6)= (((F) - m1*g*sind(x(3))*cosd(x(3)) - m1*l1*x(4)^2*sind(x(3))
- m2*l2*x(6)^2*sind(x(5)) - m2*g*sind(x(5))*cosd(x(5)))*cosd(x(5))/
(M+m1*(sind(x(3)))^2+ m2*(sind(x(5)))^2)*l2)-(g*sind(x(5)))/l1);

end

```

*Warning: Failure at t=1.010437e+00. Unable to meet integration tolerances without reducing the step size below the smallest value allowed (3.552714e-15) at time t.*

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