Table of Contents

Problem 2

```
A = [0    1   0          0;...
     0 -0.1 -0.98        1;...
     0    0   0          1;...
     0  0.1  10.78    -11];

 B = [0      0;...
      0.1  -0.1;...
      0      0;...
     -0.1   1.1];
```

a)

Compute the modes of the system

```
[V,J] = eig(A);
```

c)

Describe how much each input effects each of the modes

```
w = inv(V);

% Force affect on modes
F_M1 = w(1,:)*B(:,1);       % First mode
F_M2 = w(2,:)*B(:,1);       % Second mode
F_M3 = w(3,:)*B(:,1);       % Third mode
F_M4 = w(4,:)*B(:,1);       % Fourth mode

% Torque affect on modes
T_M1 = w(1,:)*B(:,2);      % First mode
T_M2 = w(2,:)*B(:,2);       % Second mode
T_M3 = w(3,:)*B(:,2);       % Third mode
T_M4 = w(4,:)*B(:,2);       % Fourth mode
```

d)

Determine an initial condition xo such that if x(0) = xo, then x(t) -> 0 ans t -> inf; We need xo to not affect the nodes where the eigen values are non zero. this can be done by constucting xo to be in the null space of wk that corresponds to the unstable nodes.

```
 wn = [w(1,:);w(4,:)];    % The two vectors coresponding to the
 unstable nodes
 [~,~,v] = svd(wn);       % Compute the svd to get the null space
 vn = v(:,3:4);           % Extract the null space
 P = vn*vn'/norm(vn*vn'); % Create a projection matrix that will
 project any
                          % vector onto the null space of wn.

 % Test
%  x_array = P*randn(4,10);
%  temp = w*x_array;
%  temp = round(temp,6,'significant');
% %  temp(4,:) = 0;
%  expm(J*80)*temp   %machine precision error
```

e

If the rank of the controllability matrix is the same as the number of states, then the system is fully controllable.

```
% Controllability matrix with only force
CO_F = ctrb(A,B(:,1));
rank(CO_F);

% Controllability matrix with only torque
CO_T = ctrb(A,B(:,2));
rank(CO_T);
```

Published with MATLAB® R2018a