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APSC 608 - Homework 06

For this assignment we are exploring the continuous time system defined below.

```
% continuous time system defined by ABCD

A = [-0.0558 -0.9968  0.0802  0.0415
      0.5980 -0.1150 -0.0318  0
     -3.0500  0.3880 -0.4650  0
      0       0.0805  1.0000  0];

B = [0.0073  0
    -0.4750  0.0077
     0.1530  0.1430
     0       0];

C = [0 1 0 0
     0 0 0 1];

D = [0 0
     0 0];
```

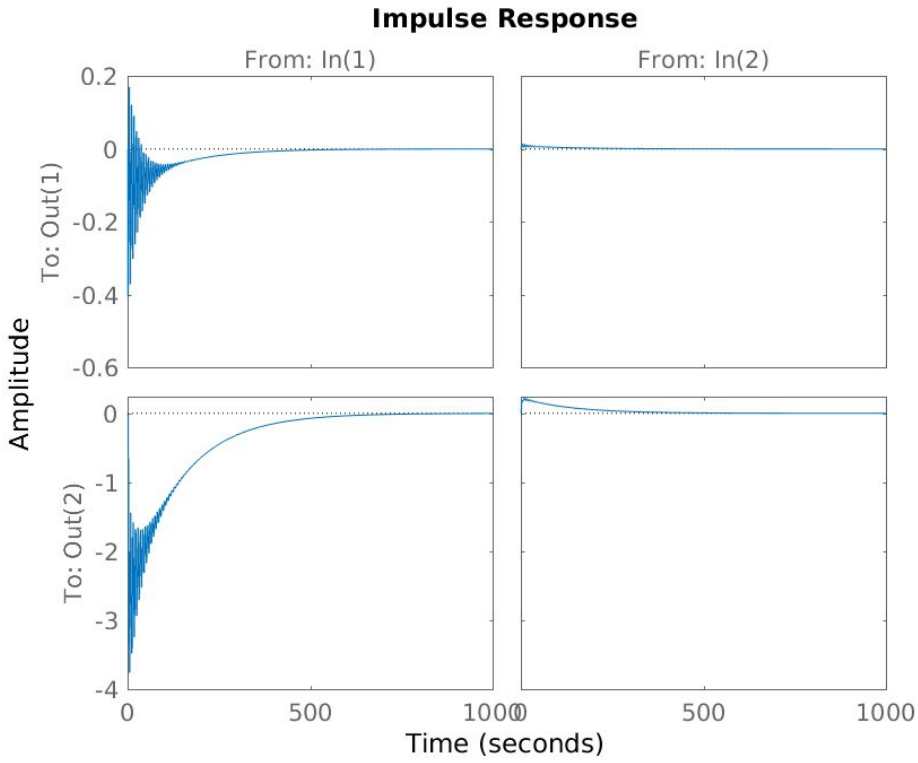
This system can be initialized and converted from continuous to discrete.

```
sysc = ss(A ,B, C, D);

% define time step
Ts = 1;

% discretize system
sysd = c2d(sysc, Ts);
```

And the system stability and impulse responses can be checked.

```
bool_stable = isstable(sysd);


impulse(sysd)
```

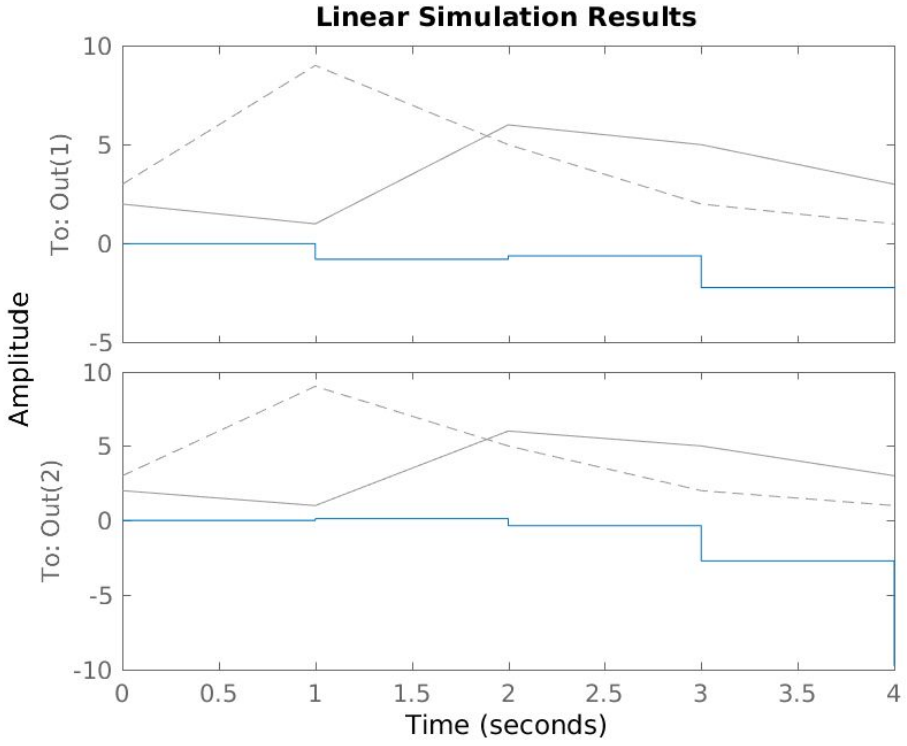
The system is stable and has 4 impulse responses (2 inputs x 2 outputs) which can be seen in the following plot.

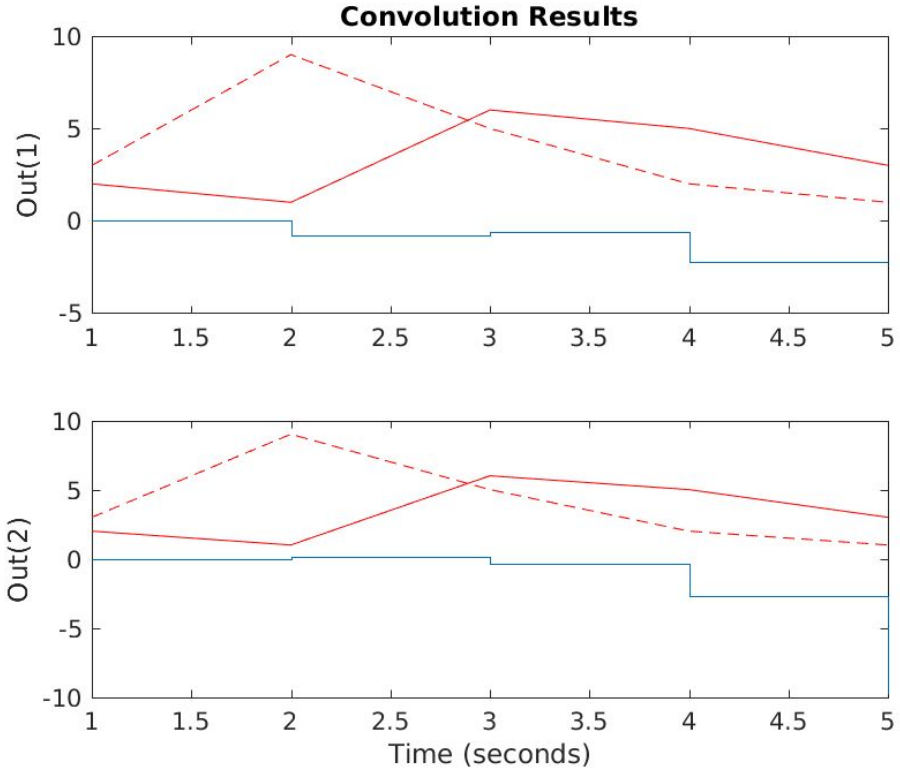


An arbitrary pair of inputs is defined which can be used to confirm that the outputs calculated using `lsim` and `conv` are identical.

```
% define input vector
u = [
    2 1 6 5 3
    3 9 5 2 1
];

% lsim
figure()
lsim(sysd, u)


[h, t] = impulse(sysd, length(u)-1);

% conv
y1 = conv(h(:,1,1)', u(1,:)) + conv(h(:,1,2)', u(2,:));
y2 = conv(h(:,2,1)', u(1,:)) + conv(h(:,2,2)', u(2,:));
```

The following two plots of the system outputs for the given inputs confirms both methods return identical results.


Linear Simulation Results
Amplitude
To: Out(1)
To: Out(2)
Time (seconds)


Convolution Results
Out(1)
Out(2)
Time (seconds)

```
% hw06

clear;
close all;

% continuous time system defined by ABCD

A = [-0.0558 -0.9968  0.0802  0.0415
      0.5980 -0.1150 -0.0318  0
     -3.0500  0.3880 -0.4650  0
      0       0.0805  1.0000  0];

B = [0.0073  0
    -0.4750  0.0077
     0.1530  0.1430
     0       0];

C = [0 1 0 0
     0 0 0 1];

D = [0 0
     0 0];

sysc = ss(A ,B, C, D);

% define time step
Ts = 1;

% discretize system
sysd = c2d(sysc, Ts);


% Is the system stable?
bool_stable = isstable(sysd);
% Yes, system is stable

% For the discrete-time system, compute all of the system's impulse
% responses
% How many inputs and outputs does this system have?
impulse(sysd)
% 4 impulse responses (2 input x 2 output)
saveas(gcf, [pwd, '/impulse.png'], 'png');


% Using both convolution and dlsim, demonstrate that you get the same
%response due to two sets of arbitrary inputs.

% define input vector
u = [
    2 1 6 5 3
    3 9 5 2 1
];

% lsim
figure()
lsim(sysd, u)

saveas(gcf, [pwd, '/system.png'], 'png');

% --------------------------------------------
```

```
[h, t] = impulse(sysd, length(u)-1);

% conv
y1 = conv(h(:,1,1)', u(1,:)) + conv(h(:,1,2)', u(2,:));
y2 = conv(h(:,2,1)', u(1,:)) + conv(h(:,2,2)', u(2,:));

figure()

subplot(2,1,1);
stairs(y1(1:5))
ylabel("Out(1)")
title("Convolution Results")
hold on
plot(u(1,:), 'r-')
plot(u(2,:), 'r--')

subplot(2,1,2);
stairs(y2(1:5))
ylabel("Out(2)")
xlabel("Time (seconds)")
hold on
plot(u(1,:), 'r-')
plot(u(2,:), 'r--')

saveas(gcf, [pwd, '/convolution.png'], 'png');
```