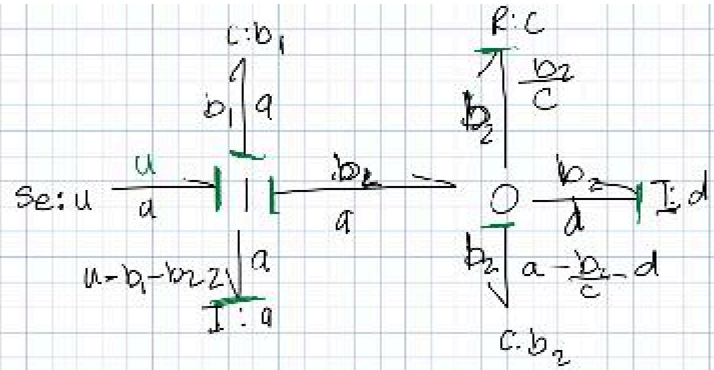
EE105 Simulinjk Lab: Block DIagram SImulation as an Engineer;s Problem Solving Tool

Name: Buddy Ugwumba SID: 862063029

Abstract

- This lab is an introduction to block diagram simulation; specifically Simulink extension of Matlab.
- Future assignments will require Simulink

Prelab



For a zero junction only one casual ~~funct~~ stroke touches it

Zero junction all efforts are the same
One junction all ~~flows~~ flows are same

$u = b_1 + b_2 + ?$

$? = u - b_1 - b_2$

$a = \frac{b}{c} + d + ?$

$? = a - \frac{b}{c} - d$

$= \frac{ac - b - dc}{c}$

3.

$x(t) = \begin{bmatrix} b_1 \\ b_2 \\ a \\ d \end{bmatrix} \in R^{4\times1}$

$\dot{F}(\alpha) = \frac{1}{\alpha} e(\alpha)$

$\dot{e}_1 = \frac{1}{b_1} F(t)$
$= \frac{1}{b_1} a$

$\dot{e}_2 = \frac{1}{b_2}(a - \frac{b_2}{c} - d$

$x_1(t) = b_1$
$\dot{x}_1(t) = \dot{b}_1$
$= \frac{1}{b_1}(a)$
$= \frac{1}{b_1} x_3(t)$

$x_2(t) = b_2$
$\dot{x}_2(t) = \dot{b}_2$
$= \frac{1}{b_2}(a - b_2/c - d)$
$= \frac{1}{b_2} a - \frac{b_2}{b_2 c} - \frac{1}{b_2} d$
$= -\frac{1}{b_2 c} x_2(t) + \frac{1}{b_2} x_3(t) - \frac{1}{b_2} x_4(t)$

$x_3(t) = a$
$\dot{x}_3(t) = \dot{a}$
$= \frac{1}{a}(u - b_1 - b_2)$
$= \frac{1}{a} u - \frac{1}{a} b_1 - \frac{1}{a} b_2$
$= -\frac{1}{a} x_1(t) - \frac{1}{a} x_2(t) + \frac{1}{a} u(t)$

$x_4(t) = d$
$\dot{x}_4(t) = \dot{d}$
$= \frac{1}{d} b_2$
$= \frac{1}{d} x_2(t)$

$$\dot{x}(t) = \begin{bmatrix} \frac{1}{b_1} x_3(t) \\ -\frac{1}{b_2 c} x_2(t) + \frac{1}{b_2} x_3(t) - \frac{1}{b_2} x_4(t) \\ -\frac{1}{a} x_1(t) - \frac{1}{a} x_2(t) + \frac{1}{a} u(t) \\ \frac{1}{d} x_2(t) \end{bmatrix}$$

$$\begin{bmatrix} 0 & 0 & 1/b_1 & 0 \\ \end{bmatrix} \begin{bmatrix} x_1 \\ \end{bmatrix} \quad \begin{bmatrix} 0 \\ \end{bmatrix}$$

2.1 (5")

```
% Output: The flow through the R-element
% Define the value for a,b,c,d and matrix A
a = 1;
b = 9;
c = 0.1;
d = 1;
A = [ 0 0 1/b 0; 0 -1/(b*c) 1/b -1/b; -1/a -1/a 0 0; 0 1/d 0 0];
% eig(A) Helps us find the poles of the system
eig(A)
```

```
ans = 4×1 complex
  -0.8727 + 0.0000i
  -0.0556 + 0.3287i
  -0.0556 - 0.3287i
  -0.1273 + 0.0000i
```

2.2

The formula can be found in the LectureNotes.

Dominant time constant: (3")

```
% tau = 1/a where a is the dominant pole
tau = 1/0.0556
```

```
tau = 17.9856
```

Time to decay away: (2")

```
% T_s = ?
T_S = 4.6/(0.0556)
```

```
T_S = 82.7338
```

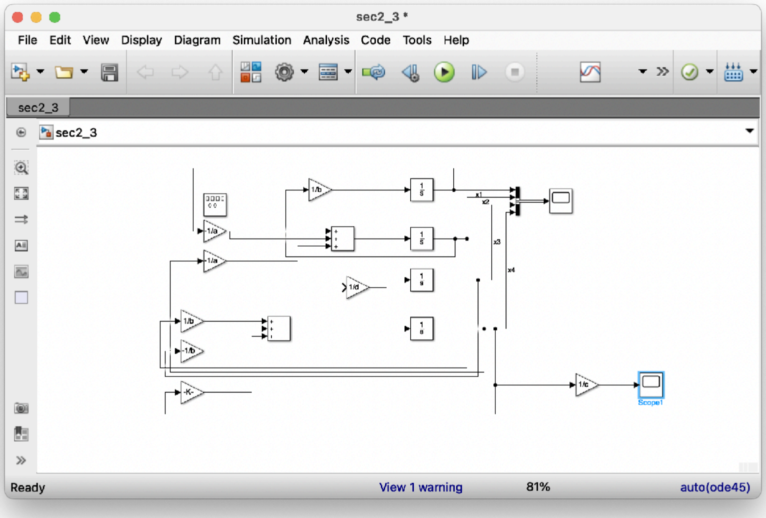
2.3

Create the Simulink model, name it as 'sec2_3'.

Simulink setting requirement: (5")

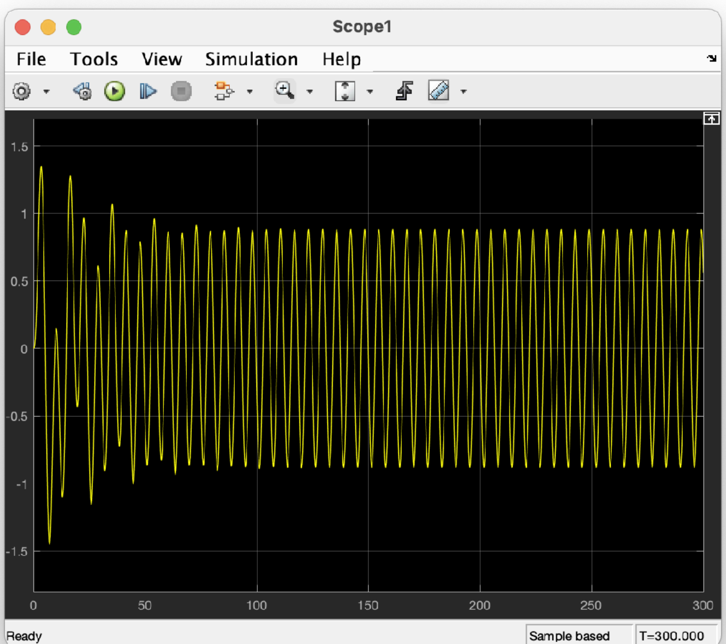
- **Stop time: 300s**
- **Max step size: 0.01**
- **Unit sinusoidal input: Amplitude = 1, Frequency = 1 rad/s**
- **In your Simulink model, do not input the specified value for 'Gain', you can just use the variable expression. like '1/c', '1/b' and so on. Before running the Simulink, you should run your live script first, to get the variables into the workspace.**

Your Simulink model: (5")



Show the simulation result for output y: (10")

(You result should be similar to the figure below:)



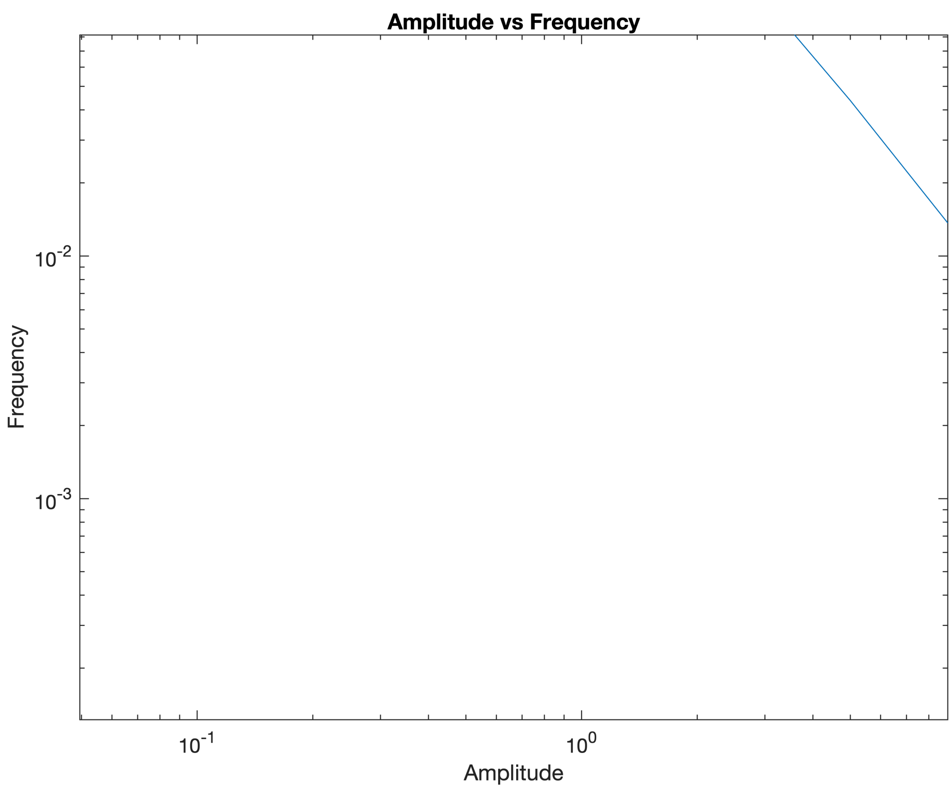
2.3 (b)

Try frequencies: 10e-3, 0.01, 0.05, 0.2, 0.27, 1/3, 0.58, 1, 5, 20, 50 rad/s

Record the amplitude of the steady-state using cusor measurement.

Plot the amplitude of the steady-state output versus the radian frequency of the input using a loglog scale. (5")

```
f = [10e-3, 0.01, 0.05, 0.2, 0.27, 1/3, 0.58, 1, 5, 20, 50];
amp = [9.005e-02 9.006e-02 4.531e-01 2.552e+00 5.124e+00 9.997e+00 2.489e+00 8.838e-01
% plot amp versus f
loglog(f,amp)
% xlabel, ylabel, title
xlabel('Amplitude')
ylabel('Frequency')
title('Amplitude vs Frequency')
```



Is there a frequency at which the output magnitude is maximum? (3")

2.3 (c) Answer Yes or No. (2")

Yes, there is a frequency at which the output magnitude is maximum. That frequency is 9.997

2.4 (50" total)

(a) (6")

```
% A has been defined in 2.1
% B = ?; C=?; D=?;
B = [0; 0; 1/a; 0];
C = [0 1/c 0 0];
```

```
D = 0;
```

(c) Since d has been defined before, using a differen variable (4")

```
% [num,den]=ss2tf(A,B,C,D)
[num,den]=ss2tf(A,B,C,D)
```

```
num = 1×5
         0         0    1.1111    0.0000   -0.0000
den = 1×5
    1.0000    1.1111    0.3333    0.1235    0.0123
```

(d) (10")

```
% Ploes?
roots(num)
```

ans = 2×1
10^{-8} ×

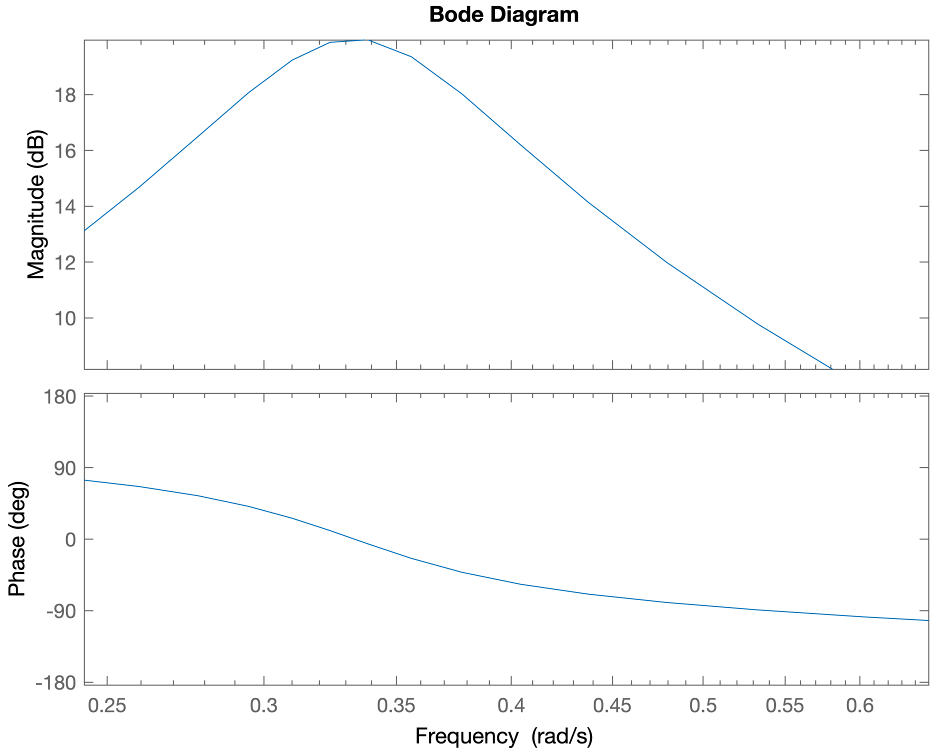
```
   -0.2953
    0.2953
```

```
% Zeros?
roots(den)
```

```
ans = 4×1 complex
  -0.8727 + 0.0000i
  -0.0556 + 0.3287i
  -0.0556 - 0.3287i
  -0.1273 + 0.0000i
```

(e)

```
% bode(num,den) (5'')
bode(num,den)
```



What will be the amplification for maximizing the gain? (5'')

The amplificiation for maximizing the gain is a frequency of 0.335 to get a gain of 19.94

2.4 Simulink:

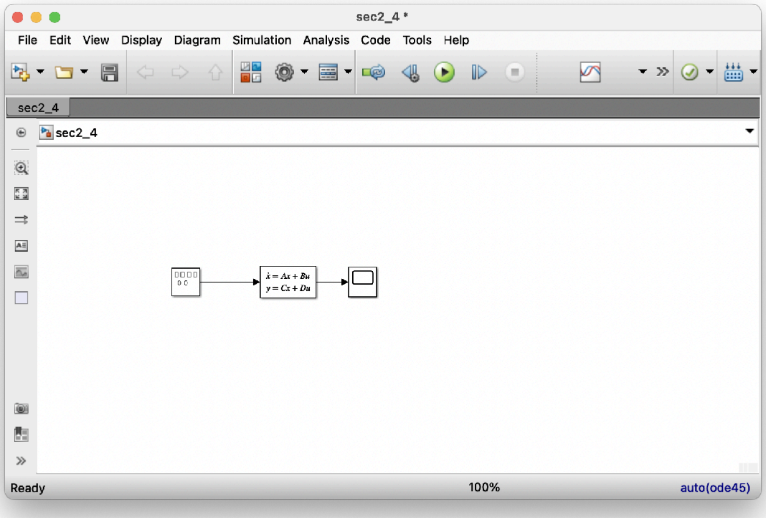
Create the Simulink model, name it as 'sec2_4'.

Simulink setting requirement for Stop time and Max step size same as what in 2.3

Notice that the input signal requency should be the one you get from the last step.

(h)

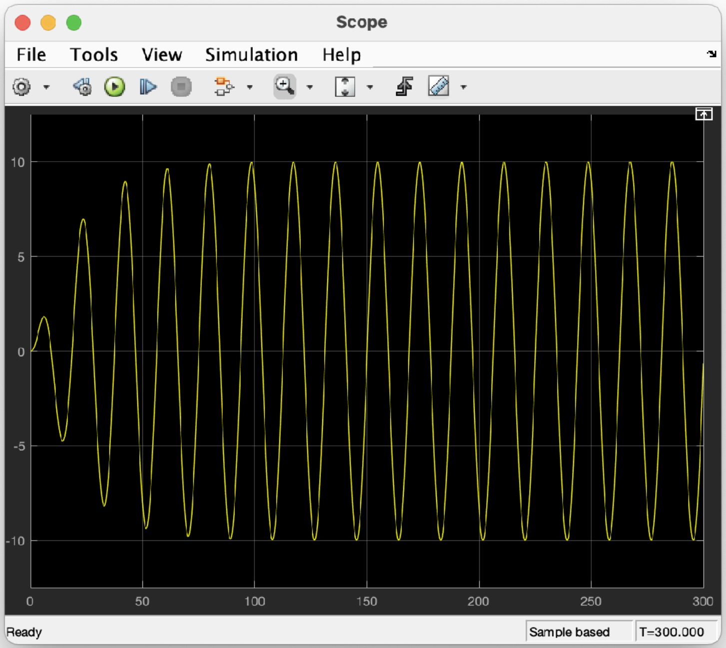
Your model: (5'')



(i)

Show the simulation result for output y: (10")

(You result should be similar to the figure below:)



(j) (5")

Using the cursor measurement measure the gain. Then compare it with the Bode plot.

```
mag2db(9.957e+00)
```

```
ans = 19.9626
```

Thus the value matches the one I got in the previous section.