CONTROL SYSTEM-2

PRACTICAL FILE

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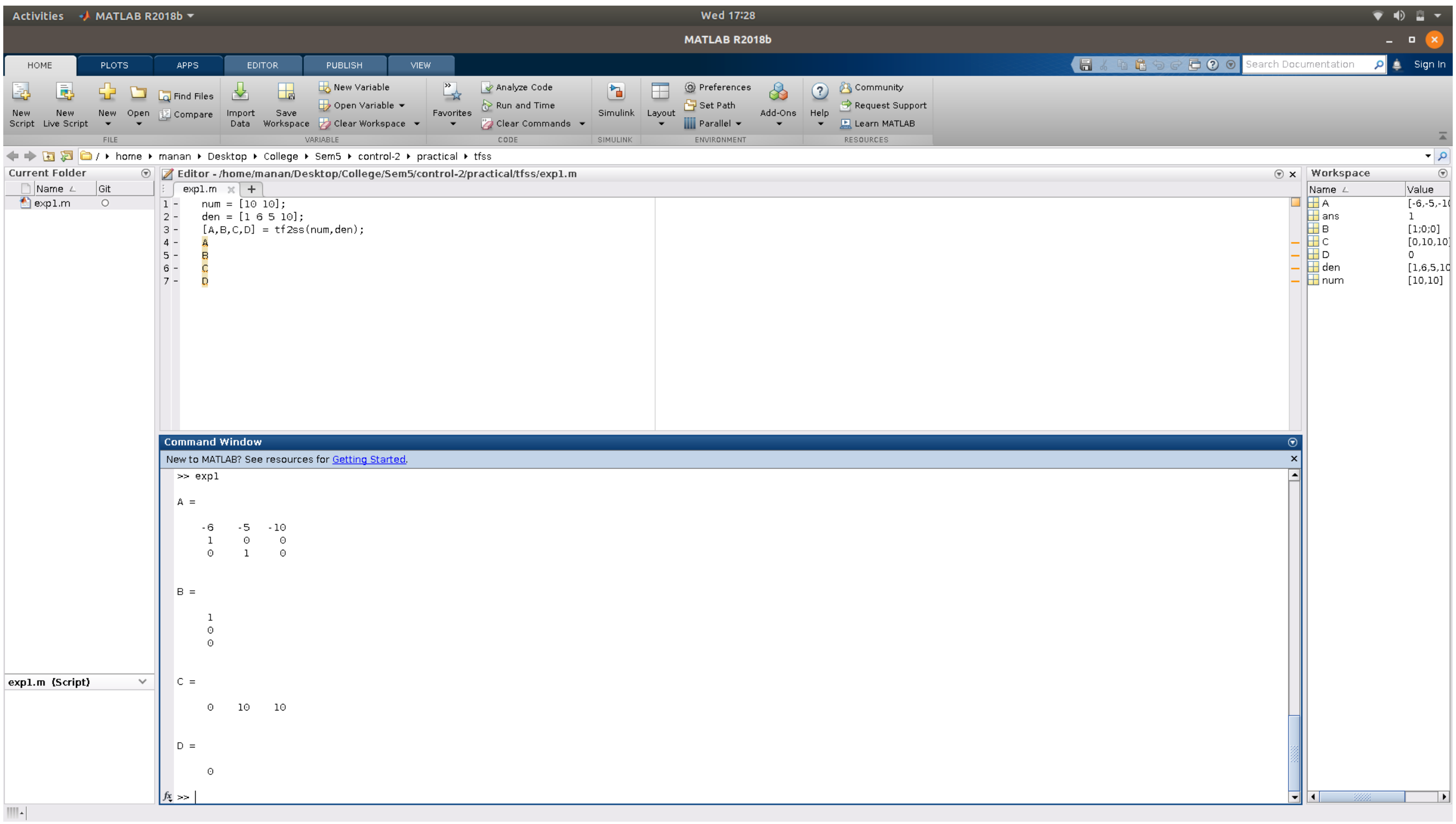
ROLL NUMBER: 2018UIC3087
Branch: Instrumentation and Control Engineering

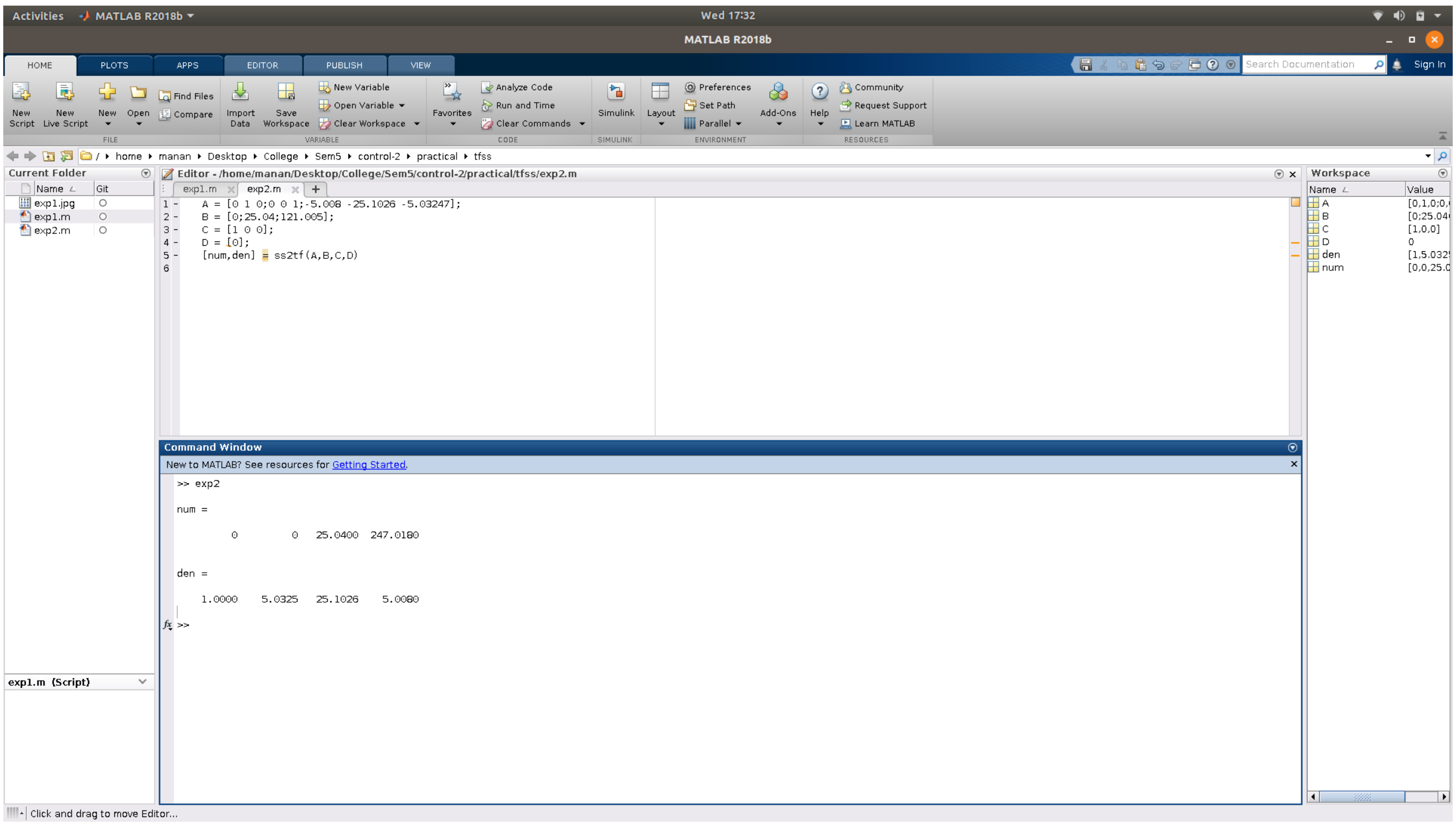
List of Experiments

S.no.	Aim	Sec 2
1	Practical problems using state space equations in MATLAB	18 August
2	Pole placement and observer design for a given state space model using MATLAB	1 September
3	Modelling and control of Cruise control system using MATLAB	22 September
4	Modelling and control of DC motor using MATLAB	29 September
5	The Frequency design method of a Cruise control system.	17 October
6	Obtain the transfer function of the system defined by the following state space equations: $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -5 & -25 & -5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 25 \\ -120 \end{bmatrix} u$ $y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$ Also obtain the unit step response of the given system.	25 November
7	Step response and impulse response of second order systems for varying damping ratio: (i) $G(s) = \frac{10}{s^2+2s+10}$ (ii) $G(s) = \frac{25}{s^2+4s+25}$	26 November
8	The Frequency design method of DC motor using MATLAB.	27 November

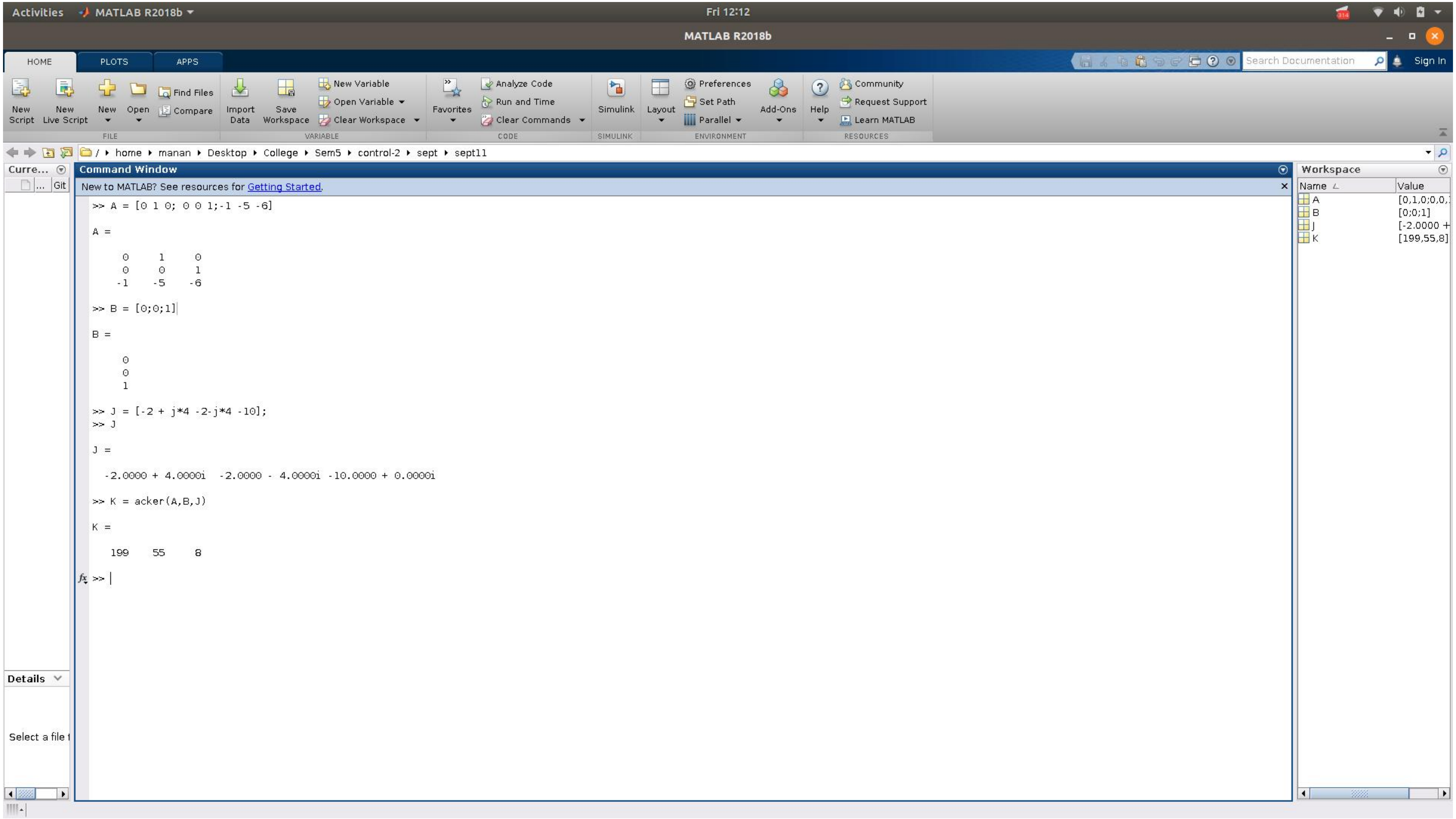
STATE SPACE AND TRANSFER FUNCTION

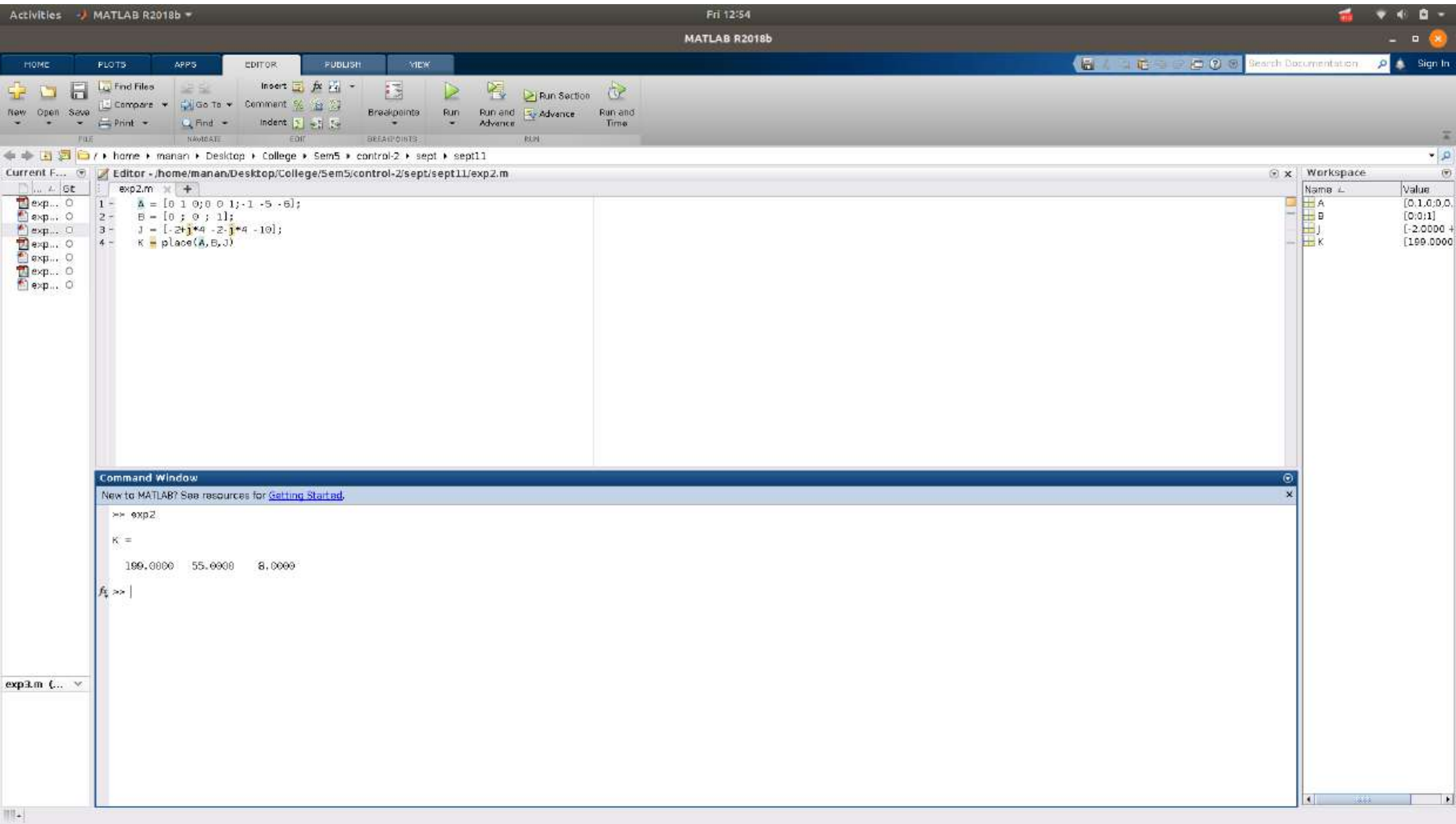


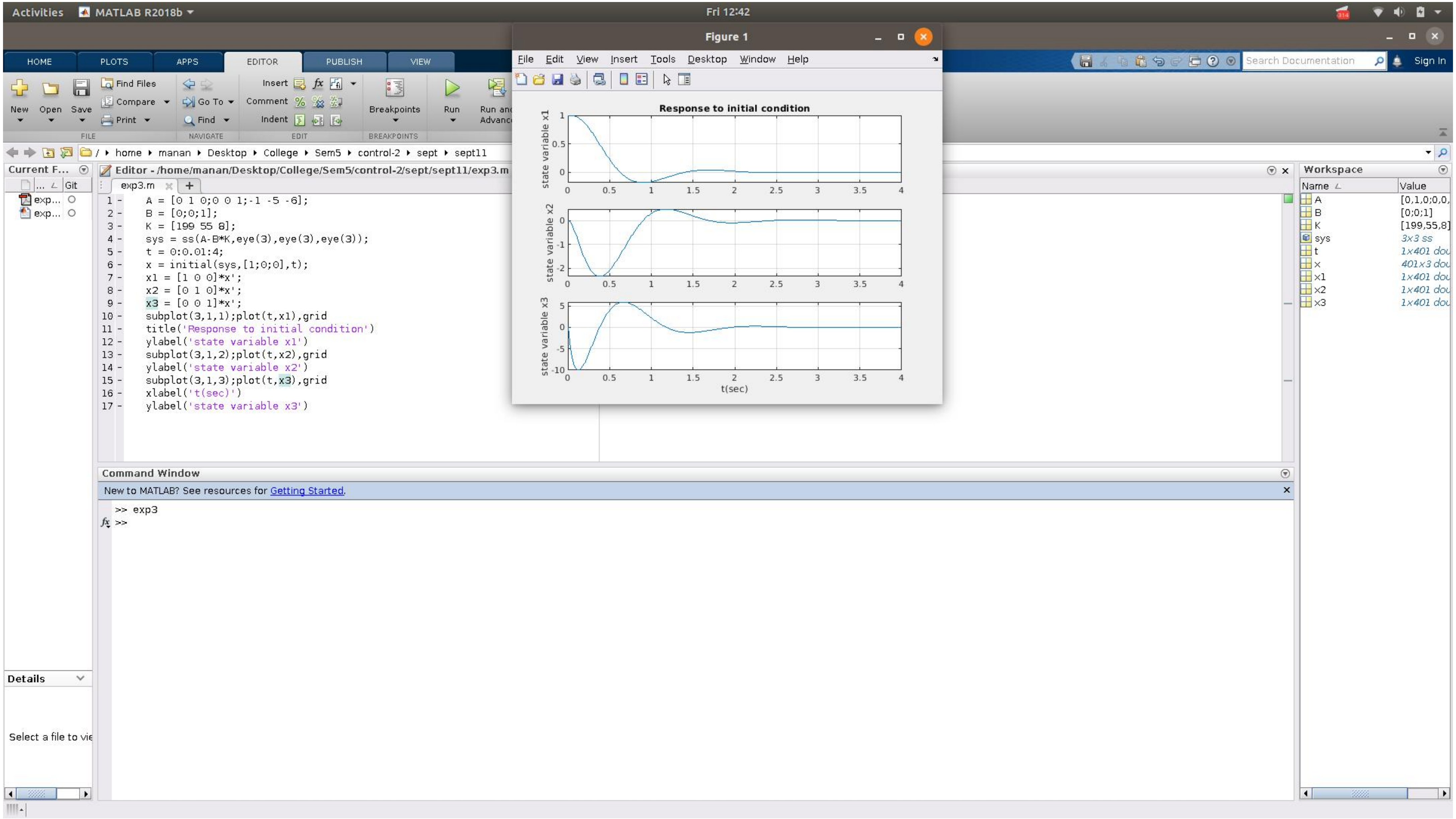
MATLAB R2018b
Editor - /home/manan/Desktop/College/Sem5/control-2/practical/tfss/exp1.m
num = [10 10];
den = [1 6 5 10];
[A,B,C,D] = tf2ss(num,den);
A
B
C
D
Command Window
>> exp1
A =
-6 -5 -10
1 0 0
0 1 0
B =
1
0
0
C =
0 10 10
D =
0
Workspace
A [-6,-5,-1
ans 1
B [1;0;0]
C [0,10,10]
D 0
den [1,6,5,10
num [10,10]


MATLAB R2018b
Editor - /home/manan/Desktop/College/Sem5/control-2/practical/tfss/exp2.m
A = [0 1 0;0 0 1;-5.008 -25.1026 -5.03247];
B = [0;25.04;121.005];
C = [1 0 0];
D = [0];
[num,den] = ss2tf(A,B,C,D)
Command Window
>> exp2
num =
0 0 25.0400 247.0180
den =
1.0000 5.0325 25.1026 5.0080
>>

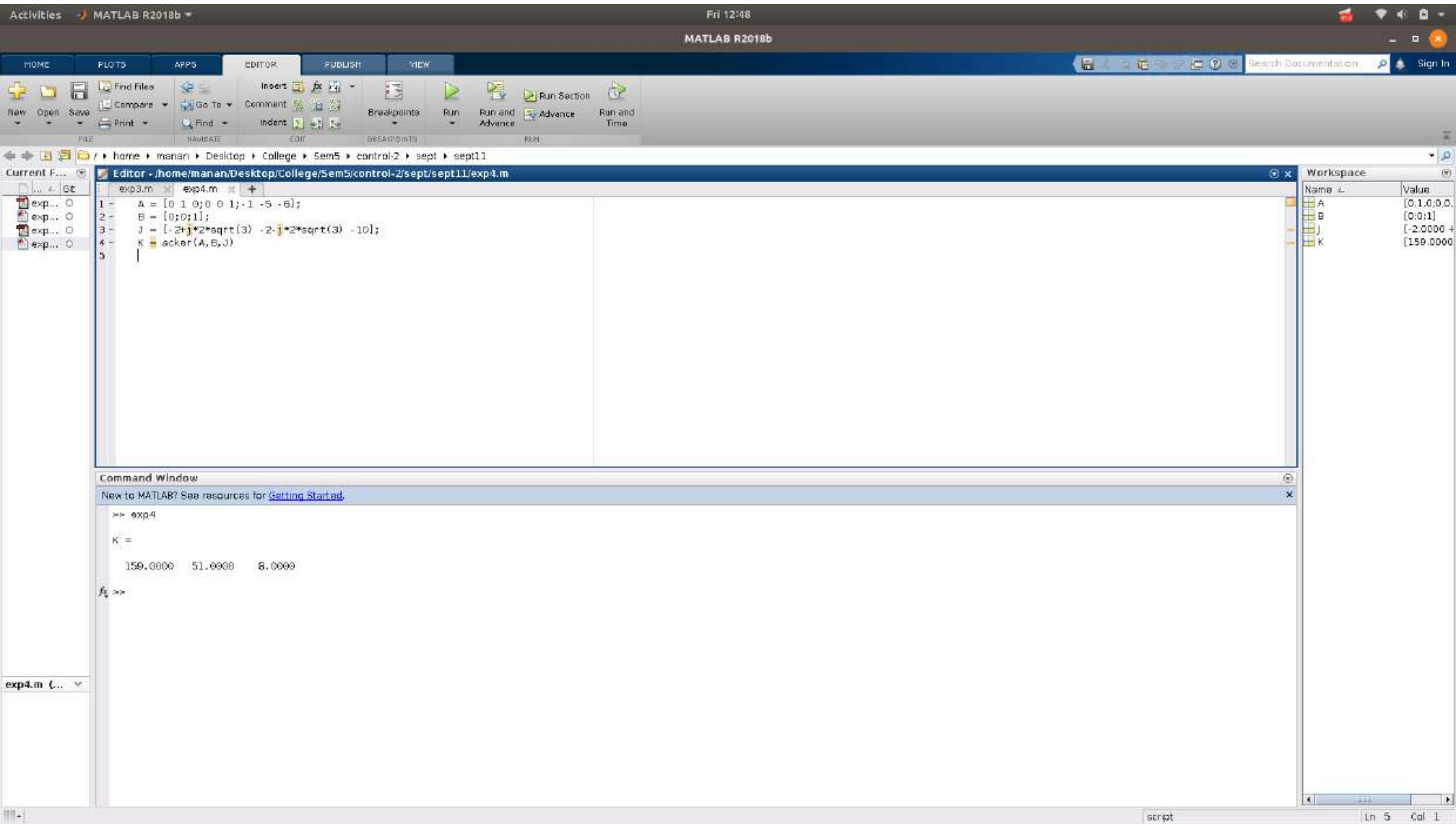
POLE PLACEMENT


MATLAB R2018b
Command Window
New to MATLAB? See resources for Getting Started.
>> A = [0 1 0; 0 0 1;-1 -5 -6]
A =
0 1 0
0 0 1
-1 -5 -6
>> B = [0;0;1]
B =
0
0
1
>> J = [-2 + j*4 -2-j*4 -10];
>> J
J =
-2.0000 + 4.0000i -2.0000 - 4.0000i -10.0000 + 0.0000i
>> K = acker(A,B,J)
K =
199 55 8
>>
Workspace
Name
Value
A
[0,1,0;0,0,
B
[0;0;1]
J
[-2.0000 +
K
[199,55,8]

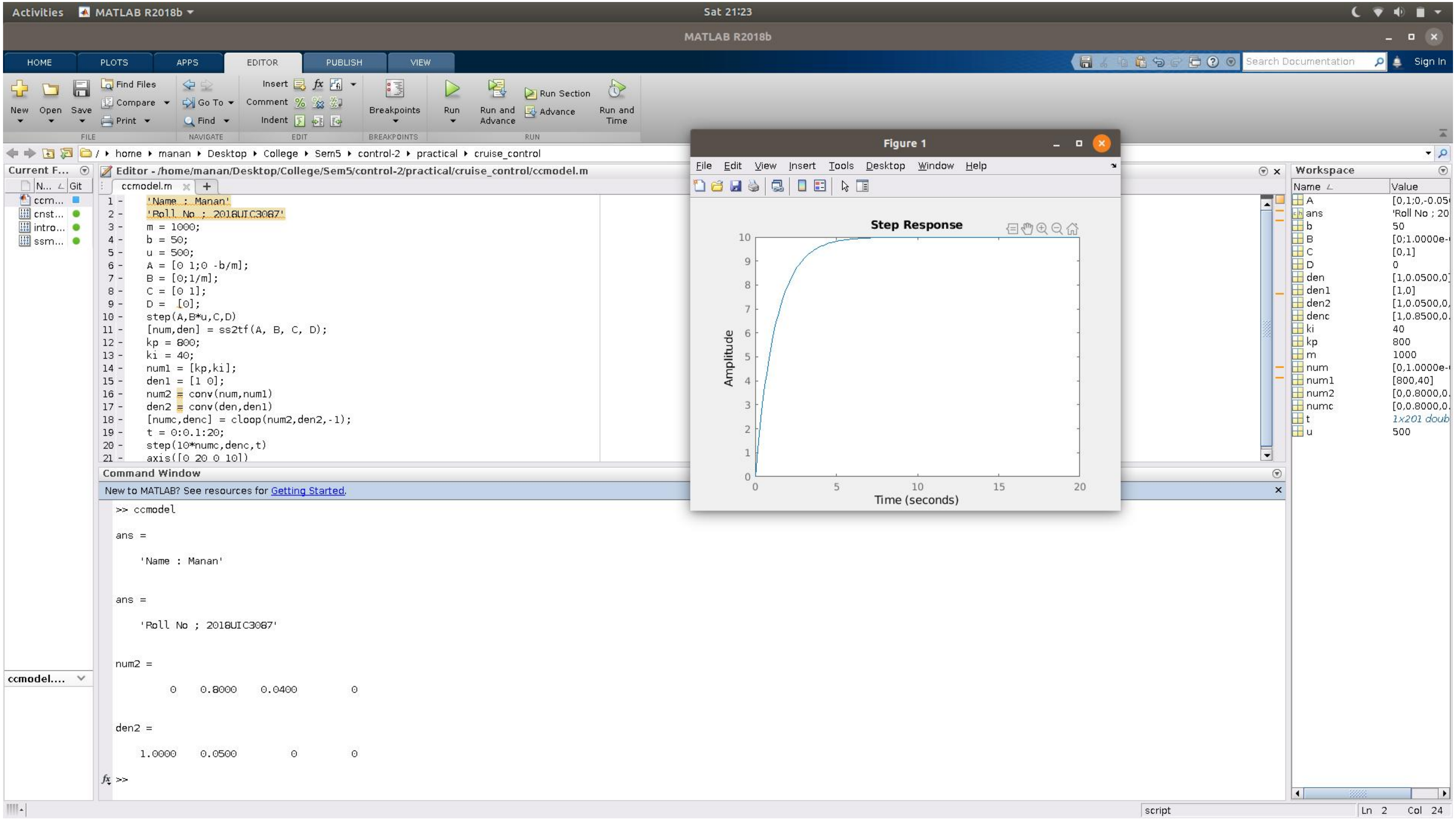

Activities
MATLAB R2018b
Fri 12:54
MATLAB R2018b
HOME
PLOTS
APPS
EDITOR
PUBLISH
VIEW
Sign In
New
Open
Save
Find Files
Compare
Print
Go To
Find
Insert
Comment
Indent
Breakpoints
Run
Run and Advance
Run Section
Advance
Run and Time
/ home manan Desktop College Sem5 control-2 sept sept11
Current F...
Editor - /home/manan/Desktop/College/Sem5/control-2/sept/sept11/exp2.m
exp2.m
A = [0 1 0;0 0 1;-1 -5 -6];
B = [0 ; 0 ; 1];
J = [-2+j*4 -2-j*4 -10];
K = place(A,B,J)
Workspace
Name
Value
A
[0,1,0;0,0,
B
[0;0;1]
J
[-2.0000 +
K
[199.0000
Command Window
New to MATLAB? See resources for Getting Started.
>> exp2
K =
199.0000 55.0000 8.0000
>>
exp3.m

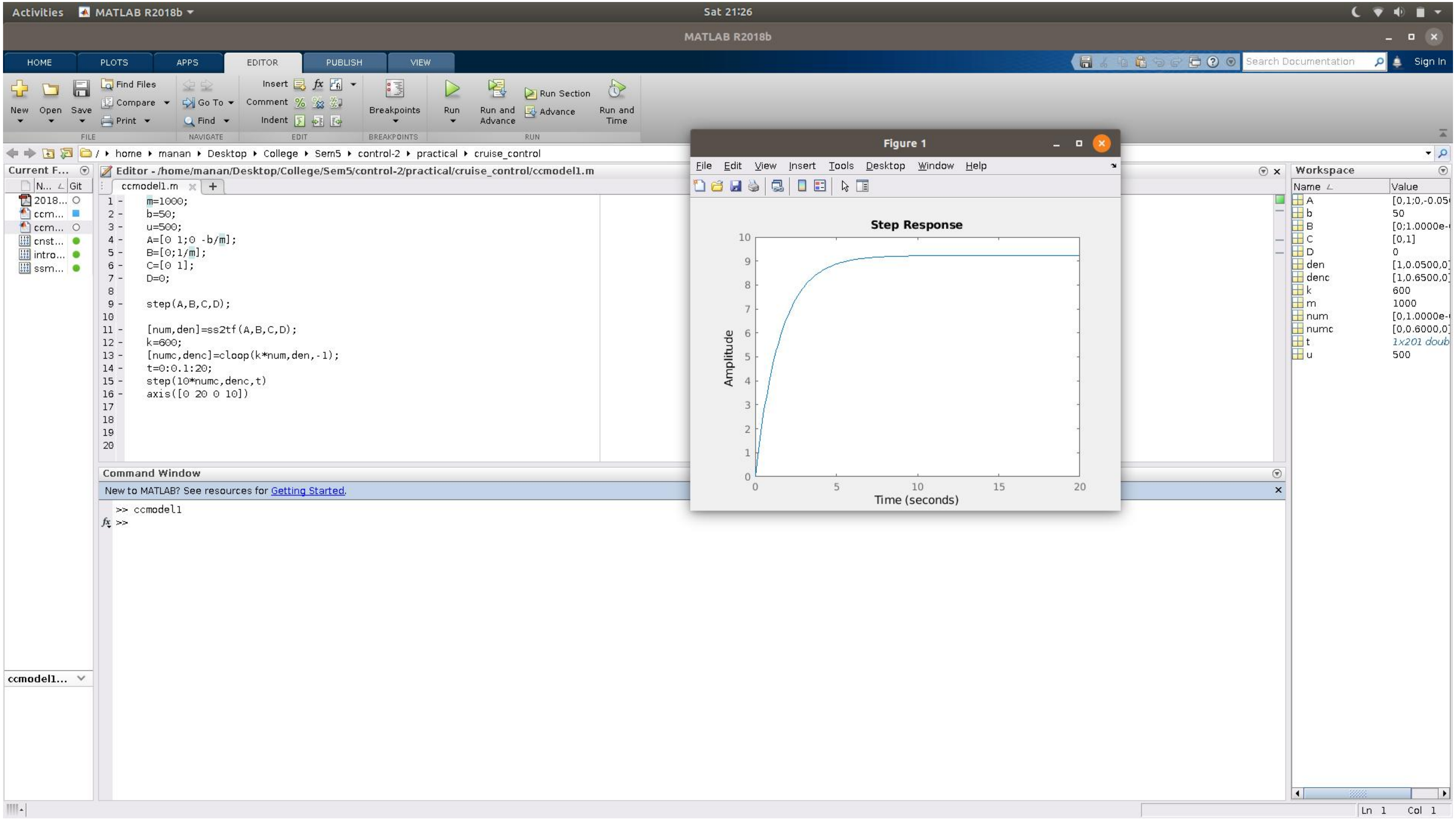


Editor - /home/manan/Desktop/College/Sem5/control-2/sept/sept11/exp3.m
A = [0 1 0;0 0 1;-1 -5 -6];
B = [0;0;1];
K = [199 55 8];
sys = ss(A-B*K,eye(3),eye(3),eye(3));
t = 0:0.01:4;
x = initial(sys,[1;0;0],t);
x1 = [1 0 0]*x';
x2 = [0 1 0]*x';
x3 = [0 0 1]*x';
subplot(3,1,1);plot(t,x1),grid
title('Response to initial condition')
ylabel('state variable x1')
subplot(3,1,2);plot(t,x2),grid
ylabel('state variable x2')
subplot(3,1,3);plot(t,x3),grid
xlabel('t(sec)')
ylabel('state variable x3')
Figure 1
Response to initial condition
state variable x1
state variable x2
state variable x3
t(sec)
Command Window
>> exp3
>>

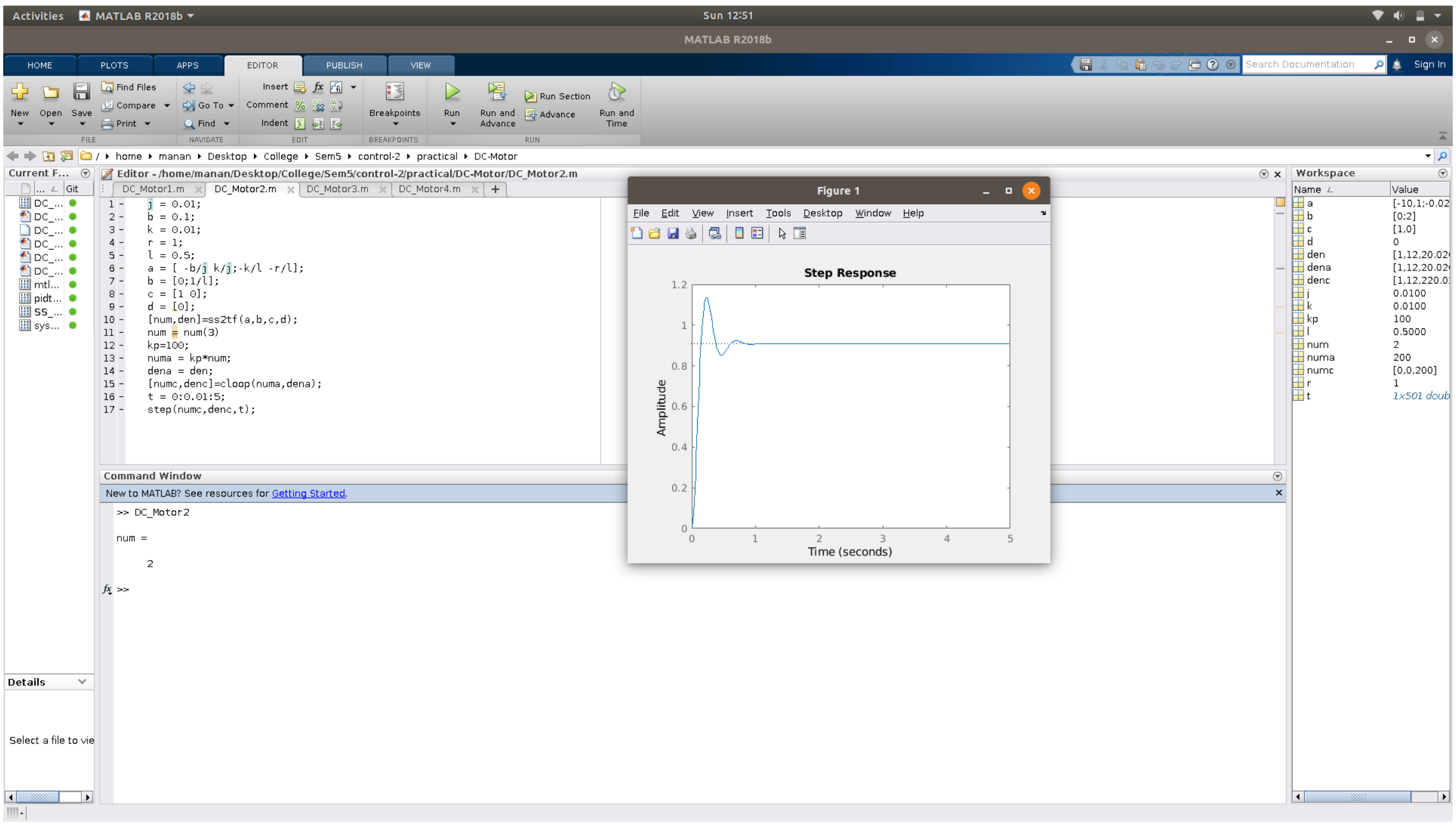

MATLAB R2018b
Editor - /home/manan/Desktop/College/Sem5/control-2/sept/sept11/exp4.m
A = [0 1 0;0 0 1;-1 -5 -6];
B = [0;0;1];
J = [-2+j*2*sqrt(3) -2-j*2*sqrt(3) -10];
K = acker(A,B,J)
Command Window
>> exp4
K =
159.0000 51.0000 8.0000
>>

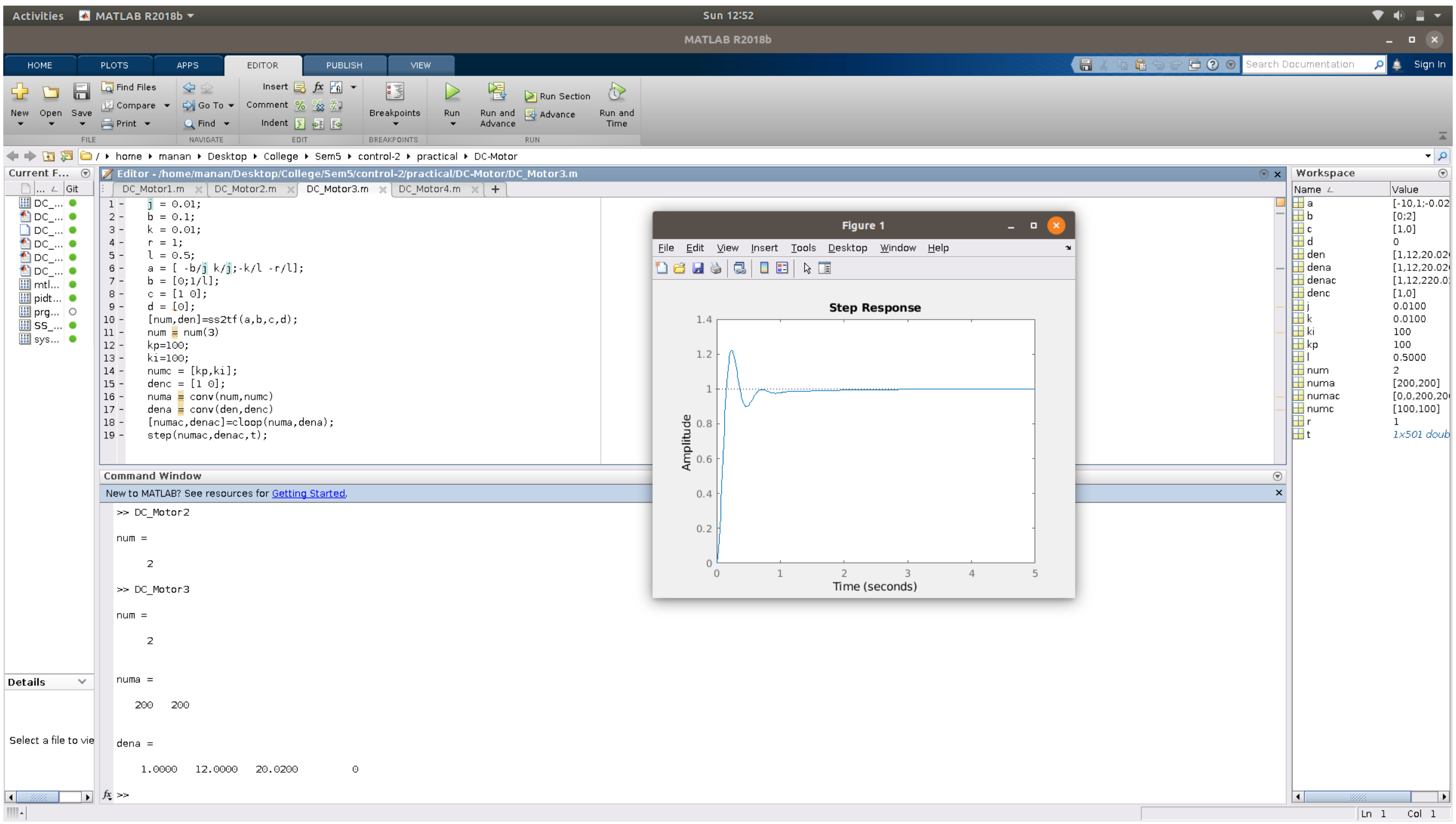
CRUISE CONTROL

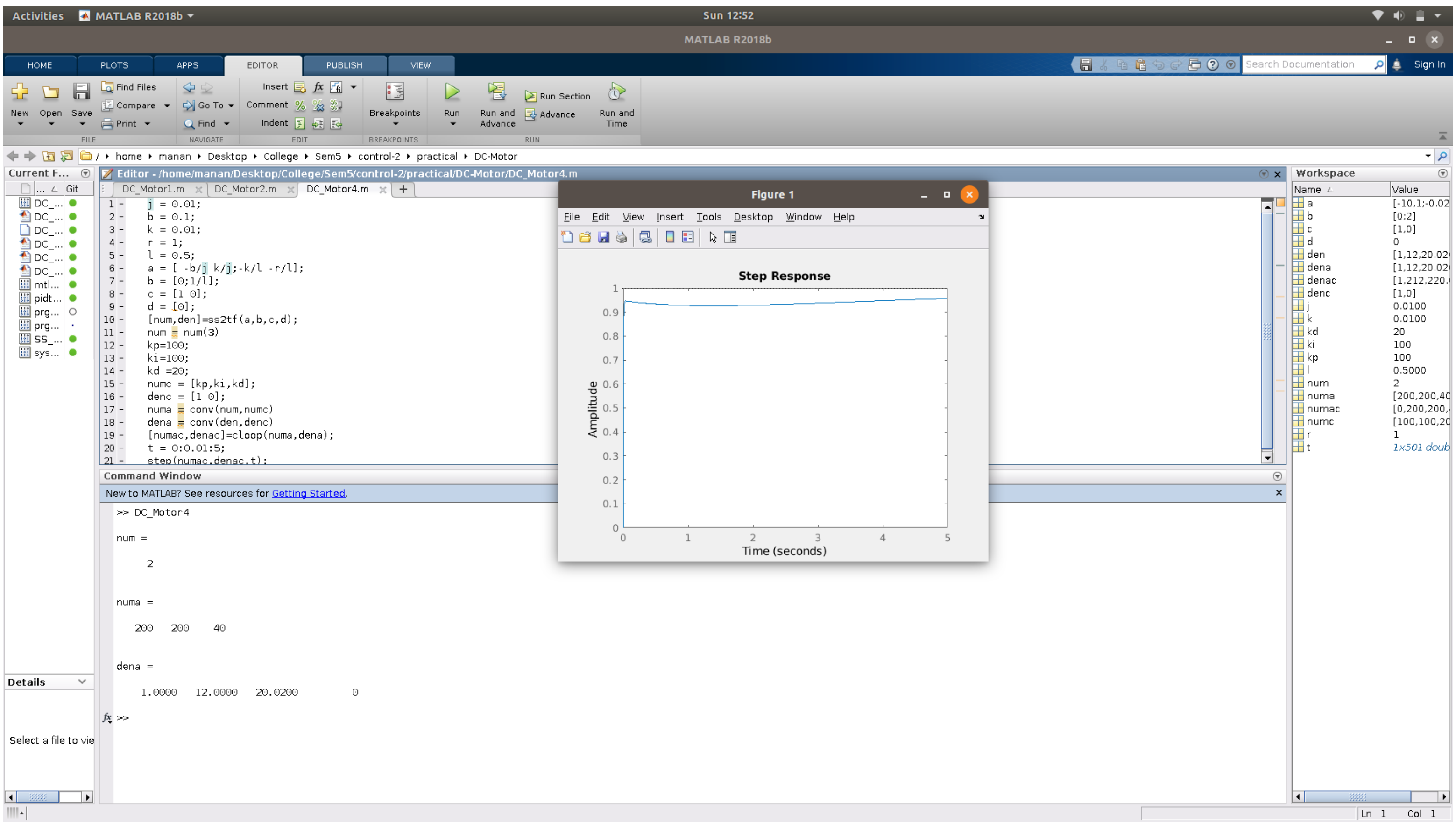

Activities MATLAB R2018b
Sat 21:23
MATLAB R2018b
HOME PLOTS APPS EDITOR PUBLISH VIEW
Editor - /home/manan/Desktop/College/Sem5/control-2/practical/cruise_control/ccmodel.m
ccmodel.m
'Name : Manan'
'Roll No ; 2018UIC3087'
m = 1000;
b = 50;
u = 500;
A = [0 1;0 -b/m];
B = [0;1/m];
C = [0 1];
D = [0];
step(A,B*u,C,D)
[num,den] = ss2tf(A, B, C, D);
kp = 800;
ki = 40;
num1 = [kp,ki];
den1 = [1 0];
num2 = conv(num,num1)
den2 = conv(den,den1)
[numc,denc] = cloop(num2,den2,-1);
t = 0:0.1:20;
step(10*numc,denc,t)
axis([0 20 0 10])
Figure 1
Step Response
Amplitude
Time (seconds)
Command Window
New to MATLAB? See resources for Getting Started.
>> ccmodel
ans =
'Name : Manan'
ans =
'Roll No ; 2018UIC3087'
num2 =
0 0.8000 0.0400 0
den2 =
1.0000 0.0500 0 0
>>
Workspace
Name Value
A [0,1;0,-0.05
ans 'Roll No ; 20
b 50
B [0;1.0000e-
C [0,1]
D 0
den [1,0.0500,0]
den1 [1,0]
den2 [1,0.0500,0,
denc [1,0.8500,0.
ki 40
kp 800
m 1000
num [0,1.0000e-
num1 [800,40]
num2 [0,0.8000,0.
numc [0,0.8000,0.
t 1x201 doub
u 500


Activities
MATLAB R2018b
Sat 21:26
MATLAB R2018b
HOME PLOTS APPS EDITOR PUBLISH VIEW
Search Documentation
Sign In
/ home manan Desktop College Sem5 control-2 practical cruise_control
Editor - /home/manan/Desktop/College/Sem5/control-2/practical/cruise_control/ccmodel1.m
ccmodel1.m
m=1000;
b=50;
u=500;
A=[0 1;0 -b/m];
B=[0;1/m];
C=[0 1];
D=0;
step(A,B,C,D);
[num,den]=ss2tf(A,B,C,D);
k=600;
[numc,denc]=cloop(k*num,den,-1);
t=0:0.1:20;
step(10*numc,denc,t)
axis([0 20 0 10])
Command Window
New to MATLAB? See resources for Getting Started.
>> ccmodel1
>>
Figure 1
Step Response
Amplitude
Time (seconds)
Workspace
Name
Value
A [0,1;0,-0.05
b 50
B [0;1.0000e-
C [0,1]
D 0
den [1,0.0500,0]
denc [1,0.6500,0]
k 600
m 1000
num [0,1.0000e-
numc [0,0.6000,0]
t 1x201 doub
u 500

DC MOTOR

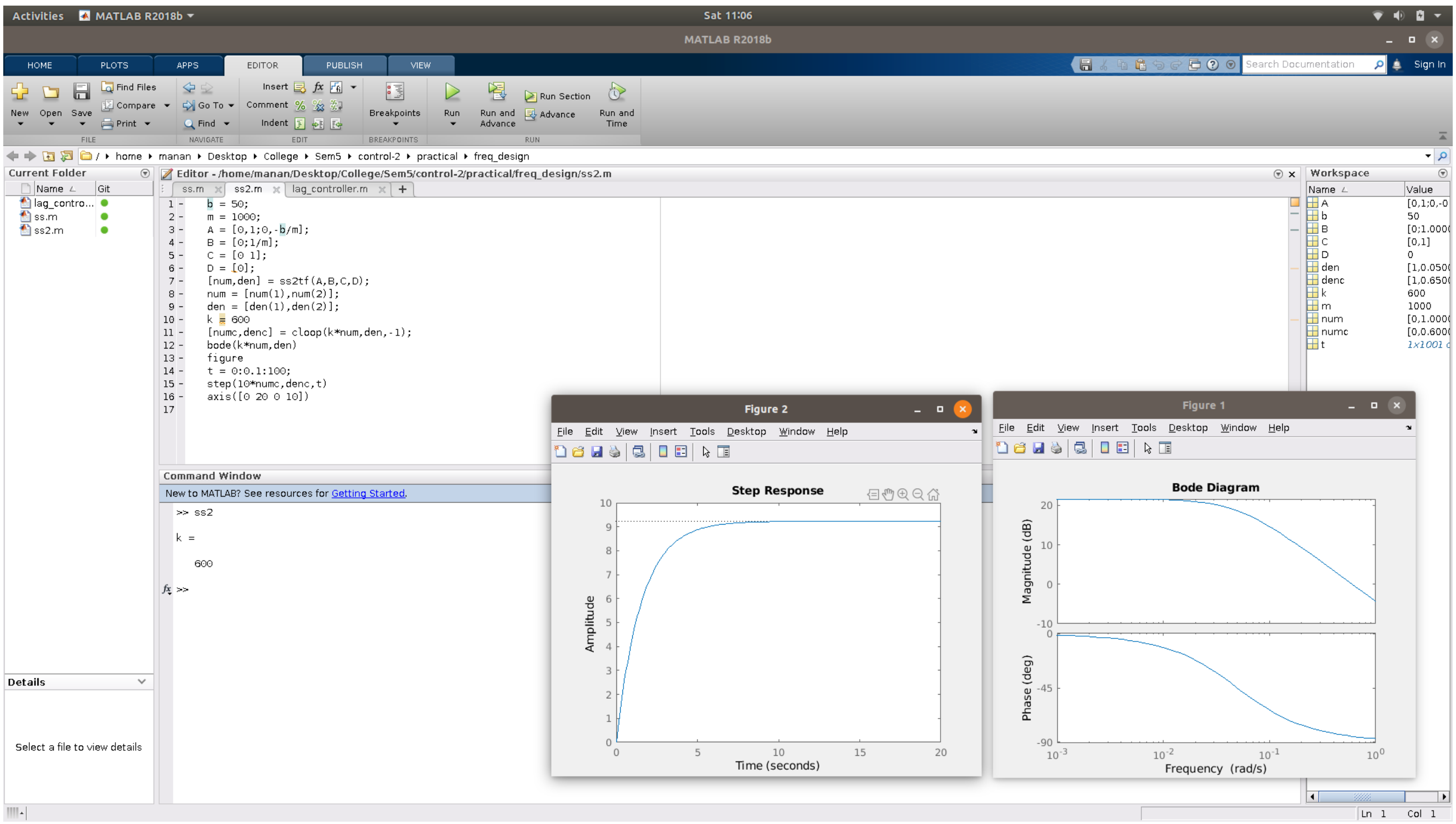

MATLAB R2018b
Editor - /home/manan/Desktop/College/Sem5/control-2/practical/DC-Motor/DC_Motor2.m
DC_Motor1.m
DC_Motor2.m
DC_Motor3.m
DC_Motor4.m
j = 0.01;
b = 0.1;
k = 0.01;
r = 1;
l = 0.5;
a = [-b/j k/j;-k/l -r/l];
b = [0;1/l];
c = [1 0];
d = [0];
[num,den]=ss2tf(a,b,c,d);
num = num(3)
kp=100;
numa = kp*num;
dena = den;
[numc,denc]=cloop(numa,dena);
t = 0:0.01:5;
step(numc,denc,t);
Command Window
>> DC_Motor2
num =
2
Figure 1
Step Response
Amplitude
Time (seconds)
Workspace
a [-10,1;-0.02
b [0;2]
c [1,0]
d 0
den [1,12,20.02
dena [1,12,20.02
denc [1,12,220.0
j 0.0100
k 0.0100
kp 100
l 0.5000
num 2
numa 200
numc [0,0,200]
r 1
t 1x501 doub

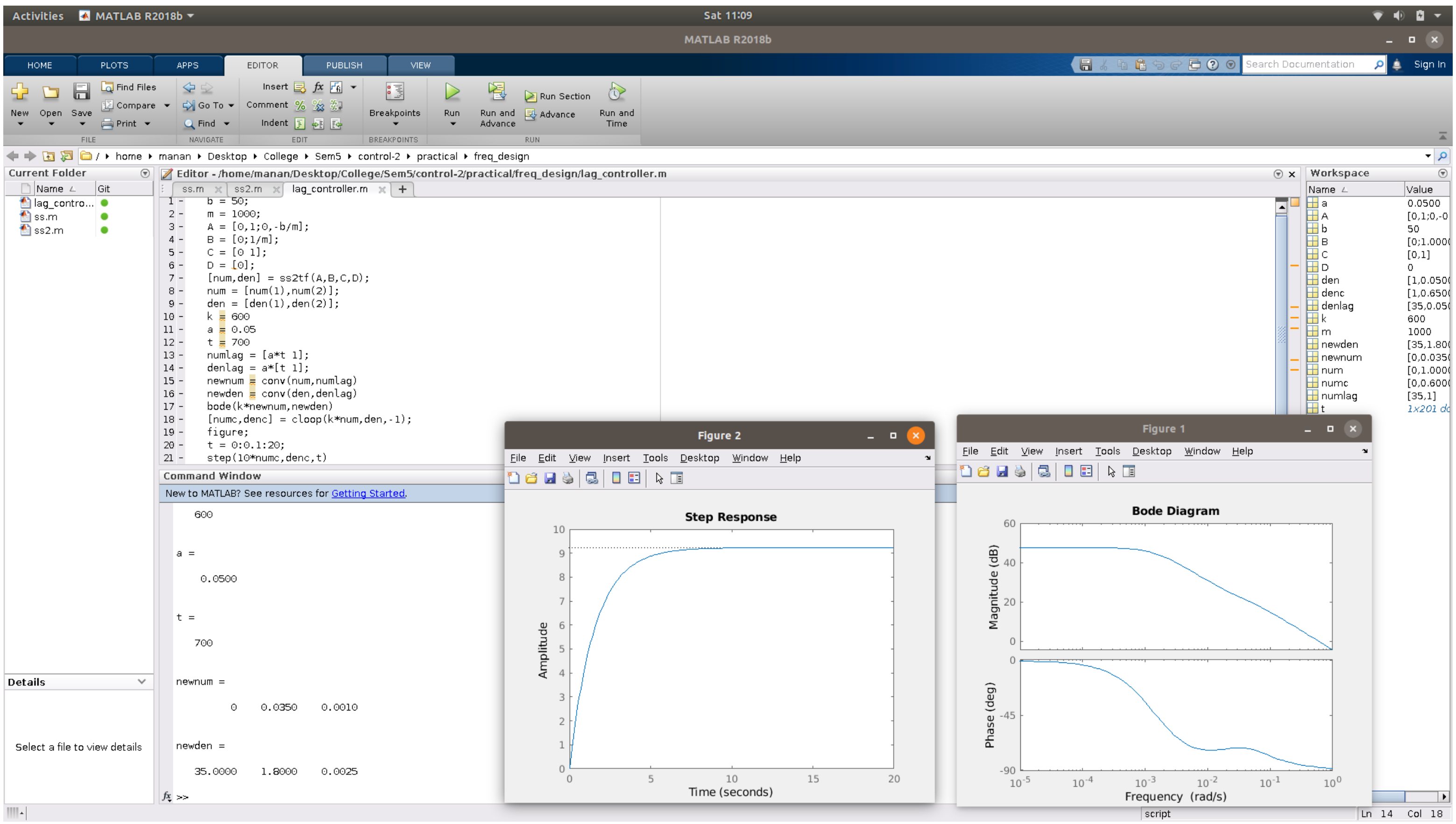

Activities
MATLAB R2018b
Sun 12:52
MATLAB R2018b
HOME
PLOTS
APPS
EDITOR
PUBLISH
VIEW
Search Documentation
Sign In
New
Open
Save
Find Files
Compare
Print
FILE
Go To
Find
NAVIGATE
Insert
Comment
Indent
EDIT
Breakpoints
BREAKPOINTS
Run
Run and Advance
Run Section
Advance
Run and Time
RUN
/ home manan Desktop College Sem5 control-2 practical DC-Motor
Current F...
Git
Editor - /home/manan/Desktop/College/Sem5/control-2/practical/DC-Motor/DC_Motor3.m
DC_Motor1.m
DC_Motor2.m
DC_Motor3.m
DC_Motor4.m
j = 0.01;
b = 0.1;
k = 0.01;
r = 1;
l = 0.5;
a = [-b/j k/j;-k/l -r/l];
b = [0;1/l];
c = [1 0];
d = [0];
[num,den]=ss2tf(a,b,c,d);
num = num(3)
kp=100;
ki=100;
numc = [kp,ki];
denc = [1 0];
numa = conv(num,numc)
dena = conv(den,denc)
[numac,denac]=cloop(numa,dena);
step(numac,denac,t);
Command Window
New to MATLAB? See resources for Getting Started.
>> DC_Motor2
num =
2
>> DC_Motor3
num =
2
numa =
200 200
dena =
1.0000 12.0000 20.0200 0
>>
Details
Select a file to vie
Figure 1
File
Edit
View
Insert
Tools
Desktop
Window
Help
Step Response
Amplitude
Time (seconds)
Workspace
Name
Value
a
[-10,1;-0.02
b
[0;2]
c
[1,0]
d
0
den
[1,12,20.02
dena
[1,12,20.02
denac
[1,12,220.0
denc
[1,0]
j
0.0100
k
0.0100
ki
100
kp
100
l
0.5000
num
2
numa
[200,200]
numac
[0,0,200,20
numc
[100,100]
r
1
t
1x501 doub
Ln 1
Col 1



MATLAB R2018b
Editor - /home/manan/Desktop/College/Sem5/control-2/practical/DC-Motor/DC_Motor4.m
DC_Motor1.m
DC_Motor2.m
DC_Motor4.m
j = 0.01;
b = 0.1;
k = 0.01;
r = 1;
l = 0.5;
a = [-b/j k/j;-k/l -r/l];
b = [0;1/l];
c = [1 0];
d = [0];
[num,den]=ss2tf(a,b,c,d);
num = num(3)
kp=100;
ki=100;
kd =20;
numc = [kp,ki,kd];
denc = [1 0];
numa = conv(num,numc)
dena = conv(den,denc)
[numac,denac]=cloop(numa,dena);
t = 0:0.01:5;
step(numac,denac,t);
Figure 1
Step Response
Amplitude
Time (seconds)
Command Window
>> DC_Motor4
num =
2
numa =
200 200 40
dena =
1.0000 12.0000 20.0200 0
Workspace
Name
Value

FREQUENCY DESIGN

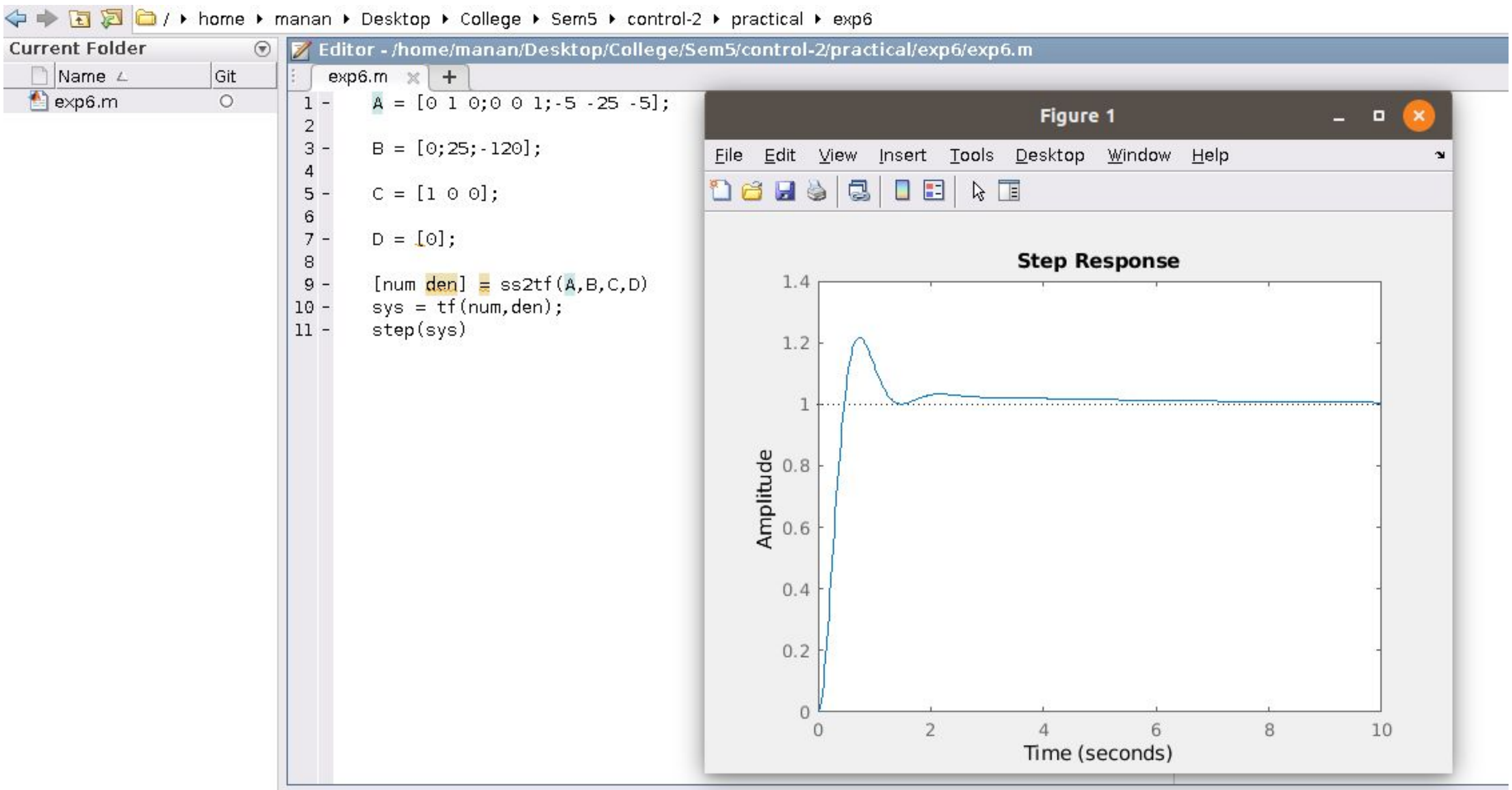

MATLAB R2018b
Editor - /home/manan/Desktop/College/Sem5/control-2/practical/freq_design/ss2.m
b = 50;
m = 1000;
A = [0,1;0,-b/m];
B = [0;1/m];
C = [0 1];
D = [0];
[num,den] = ss2tf(A,B,C,D);
num = [num(1),num(2)];
den = [den(1),den(2)];
k = 600
[numc,denc] = cloop(k*num,den,-1);
bode(k*num,den)
figure
t = 0:0.1:100;
step(10*numc,denc,t)
axis([0 20 0 10])
Command Window
>> ss2
k =
600
Figure 2
Step Response
Amplitude
Time (seconds)
Figure 1
Bode Diagram
Magnitude (dB)
Phase (deg)
Frequency (rad/s)


Editor - /home/manan/Desktop/College/Sem5/control-2/practical/freq_design/lag_controller.m
b = 50;
m = 1000;
A = [0,1;0,-b/m];
B = [0;1/m];
C = [0 1];
D = [0];
[num,den] = ss2tf(A,B,C,D);
num = [num(1),num(2)];
den = [den(1),den(2)];
k = 600
a = 0.05
t = 700
numlag = [a*t 1];
denlag = a*[t 1];
newnum = conv(num,numlag)
newden = conv(den,denlag)
bode(k*newnum,newden)
[numc,denc] = cloop(k*num,den,-1);
figure;
t = 0:0.1:20;
step(10*numc,denc,t)
Command Window
600
a =
0.0500
t =
700
newnum =
0 0.0350 0.0010
newden =
35.0000 1.8000 0.0025
Figure 2
Step Response
Amplitude
Time (seconds)
Figure 1
Bode Diagram
Magnitude (dB)
Phase (deg)
Frequency (rad/s)

Obtain the transfer function of the system-defined by the following state-space equations:

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -5 & -25 & -5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 25 \\ -120 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

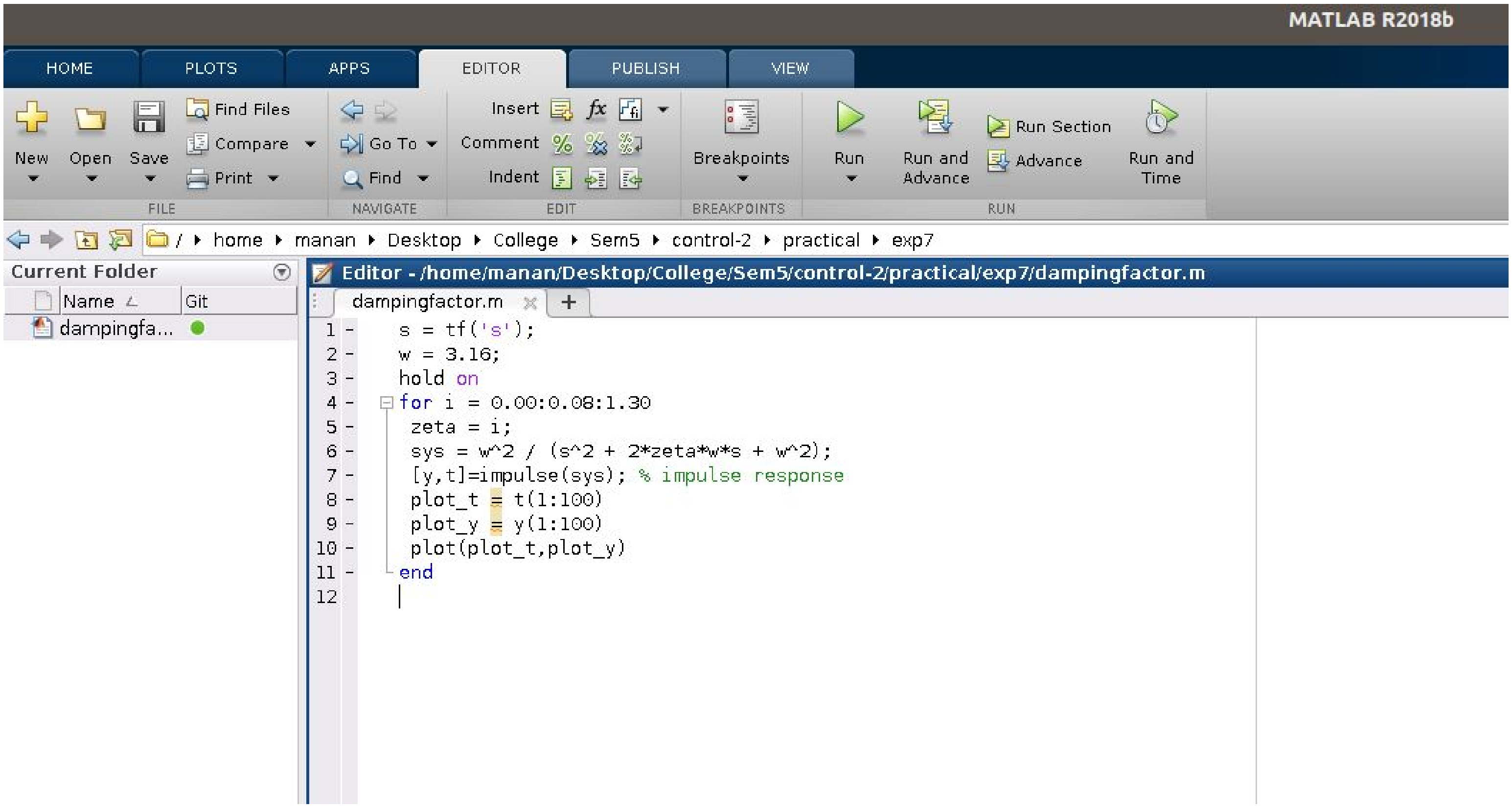

/ home manan Desktop College Sem5 control-2 practical exp6
Current Folder
Name
Git
exp6.m
Editor - /home/manan/Desktop/College/Sem5/control-2/practical/exp6/exp6.m
exp6.m
A = [0 1 0;0 0 1;-5 -25 -5];
B = [0;25;-120];
C = [1 0 0];
D = [0];
[num den] = ss2tf(A,B,C,D)
sys = tf(num,den);
step(sys)
Figure 1
File Edit View Insert Tools Desktop Window Help
Step Response
Amplitude
Time (seconds)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0
2
4
6
8
10

Step response and impulse response of second-order systems for varying damping ratio:

(i) G(s) = $\frac{10}{s^2+2s+10}$

(ii) G(s) = $\frac{25}{s^2+4s+25}$

Part 1


MATLAB R2018b
HOME
PLOTS
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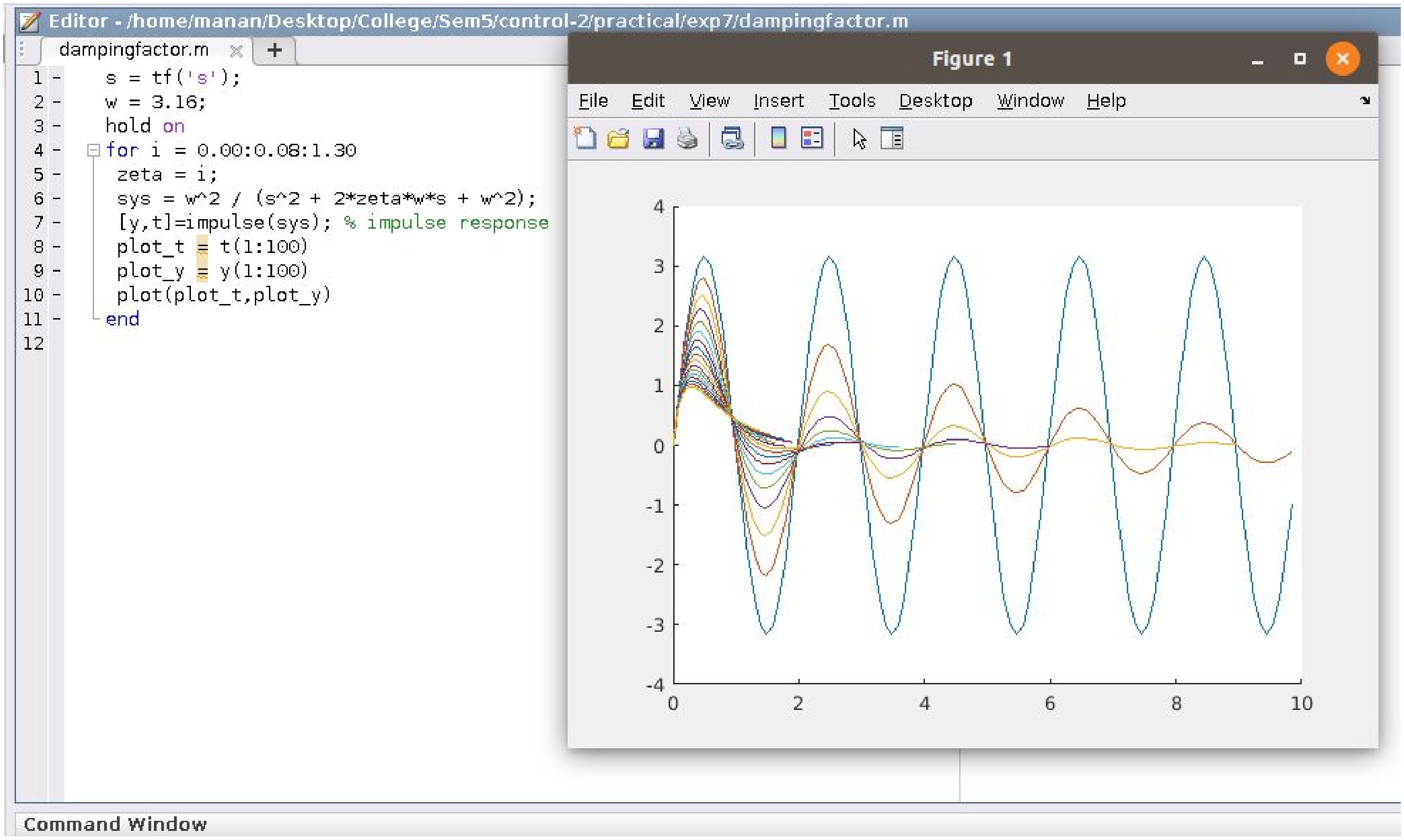
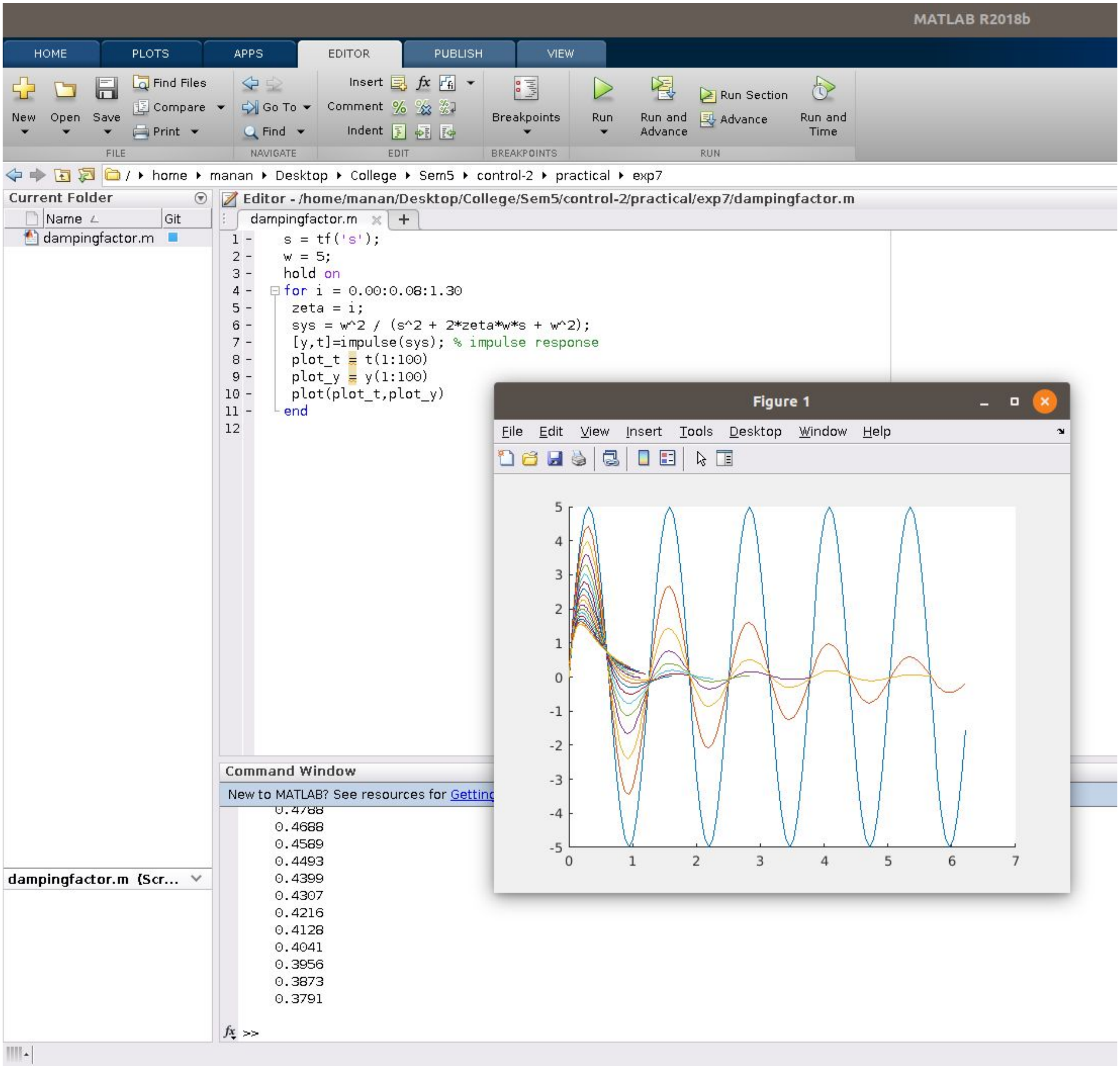
Compare
Print
FILE
Go To
Find
NAVIGATE
Insert
Comment
Indent
EDIT
Breakpoints
BREAKPOINTS
Run
Run and Advance
Run Section
Advance
Run and Time
RUN
/ home manan Desktop College Sem5 control-2 practical exp7
Current Folder
Name
Git
dampingfa...
Editor - /home/manan/Desktop/College/Sem5/control-2/practical/exp7/dampingfactor.m
dampingfactor.m
s = tf('s');
w = 3.16;
hold on
for i = 0.00:0.08:1.30
zeta = i;
sys = w^2 / (s^2 + 2*zeta*w*s + w^2);
[y,t]=impulse(sys); % impulse response
plot_t = t(1:100)
plot_y = y(1:100)
plot(plot_t,plot_y)
end

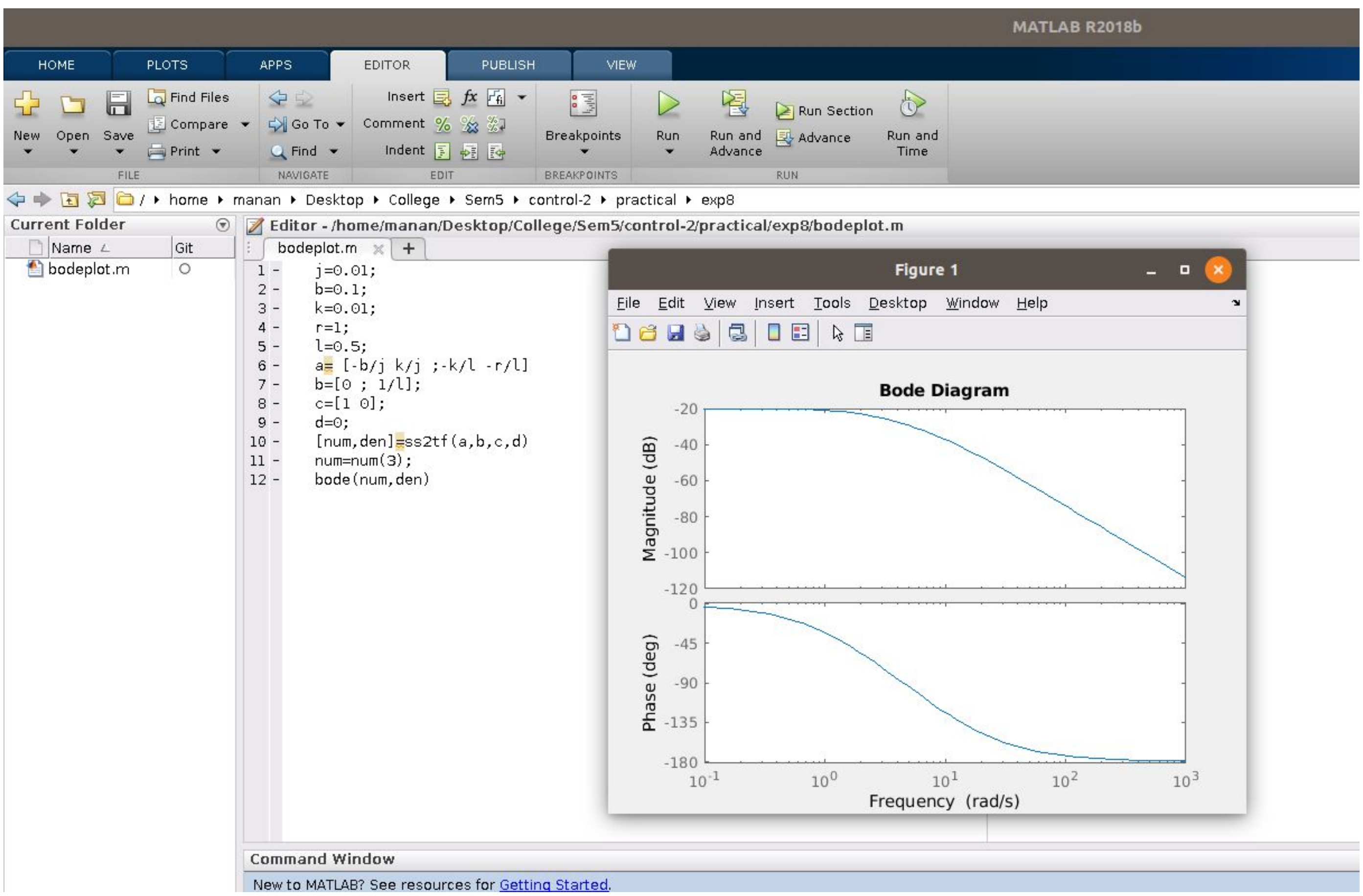

Editor - /home/manan/Desktop/College/Sem5/control-2/practical/exp7/dampingfactor.m
dampingfactor.m
s = tf('s');
w = 3.16;
hold on
for i = 0.00:0.08:1.30
zeta = i;
sys = w^2 / (s^2 + 2*zeta*w*s + w^2);
[y,t]=impulse(sys); % impulse response
plot_t = t(1:100)
plot_y = y(1:100)
plot(plot_t,plot_y)
end
Figure 1
File Edit View Insert Tools Desktop Window Help
4
3
2
1
0
-1
-2
-3
-4
0
2
4
6
8
10
Command Window

Part 2

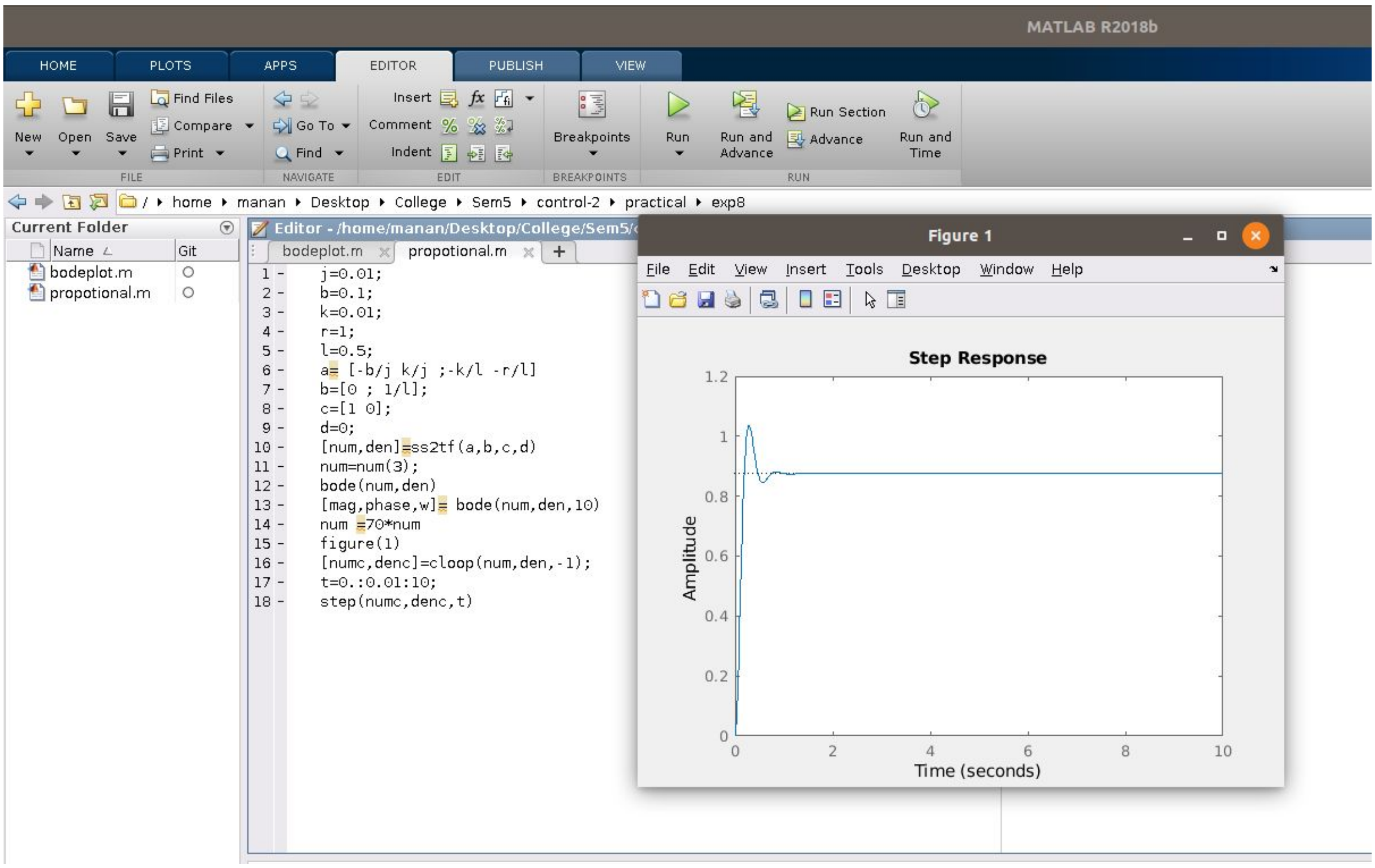

MATLAB R2018b
HOME
PLOTS
APPS
EDITOR
PUBLISH
VIEW
Editor - /home/manan/Desktop/College/Sem5/control-2/practical/exp7/dampingfactor.m
dampingfactor.m
s = tf('s');
w = 5;
hold on
for i = 0.00:0.08:1.30
zeta = i;
sys = w^2 / (s^2 + 2*zeta*w*s + w^2);
[y,t]=impulse(sys); % impulse response
plot_t = t(1:100)
plot_y = y(1:100)
plot(plot_t,plot_y)
end
Command Window
0.4688
0.4589
0.4493
0.4399
0.4307
0.4216
0.4128
0.4041
0.3956
0.3873
0.3791
Figure 1
File
Edit
View
Insert
Tools
Desktop
Window
Help

The Frequency design method of DC motor using MATLAB.

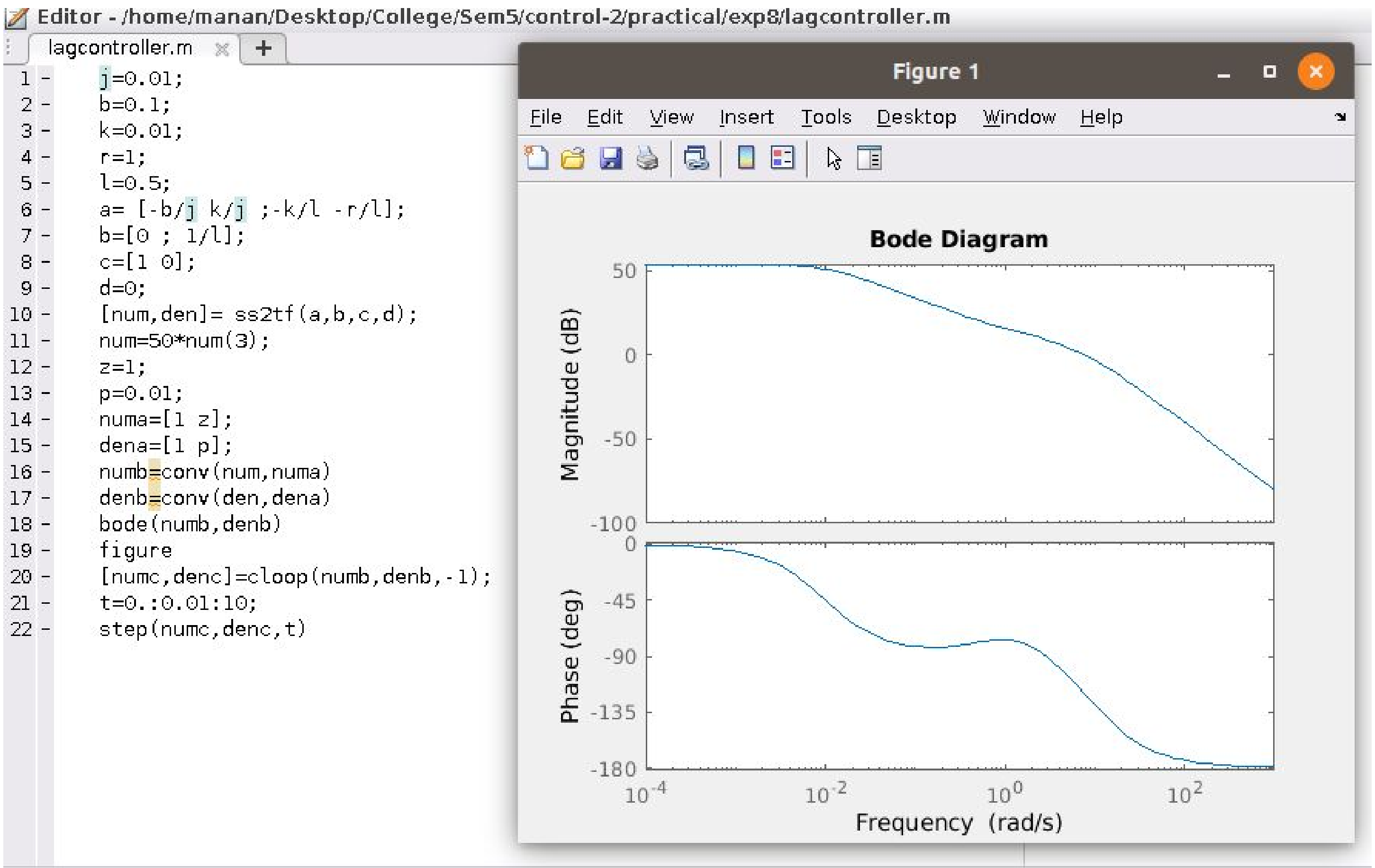
- **Bode Plot:**


MATLAB R2018b
HOME
PLOTS
APPS
EDITOR
PUBLISH
VIEW
Current Folder
bodeplot.m
Editor - /home/manan/Desktop/College/Sem5/control-2/practical/exp8/bodeplot.m
j=0.01;
b=0.1;
k=0.01;
r=1;
l=0.5;
a= [-b/j k/j ;-k/l -r/l]
b=[0 ; 1/l];
c=[1 0];
d=0;
[num,den]=ss2tf(a,b,c,d)
num=num(3);
bode(num,den)
Figure 1
Bode Diagram
Magnitude (dB)
Phase (deg)
Frequency (rad/s)
Command Window
New to MATLAB? See resources for Getting Started.

- For Proportional Gain:



- For Lag Controller



Editor - /home/manan/Desktop/College/Sem5/control-2/practical/exp8/lagcontroller.m

lagcontroller.m

```
j=0.01;
b=0.1;
k=0.01;
r=1;
l=0.5;
a= [-b/j k/j ;-k/l -r/l];
b=[0 ; 1/l];
c=[1 0];
d=0;
[num,den]= ss2tf(a,b,c,d);
num=50*num(3);
z=1;
p=0.01;
numa=[1 z];
dena=[1 p];
numb=conv(num,numa)
denb=conv(den,dena)
bode(numb,denb)
figure
[numc,denc]=cloop(numb,denb,-1);
t=0.:0.01:10;
step(numc,denc,t)
```