Winter Training Report

By
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Submitted to
Instrumentation and Control Engineering Division
NETAJI SUBHAS INSTITUTE OF TECHNOLOGY, NEW DELHI

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<u>CERTIFICATE</u>

This is to certify that the work presented in this report entitled **“**Modeling, Analysis and Simulation using MATLAB**”**, submitted by Rahul Prakash (Roll No. 503/IC/11) to the Division of Instrumentation and Control Engineering, Netaji Subhas Institute of Technology, New Delhi a record of my own work carried out under the supervision and guidance of Mr. Sreejith S Nair, ICED.

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This is to certify that the work presented in this report entitled **“**Modeling, Analysis and Simulation using MATLAB**”,** submitted by Rahul Prakash (Roll No. 503/IC/11) to the Division of Instrumentation and Control Engineering, Netaji Subhas Institute of Technology, New Delhi a record of the student’s own work carried out under my supervision and guidance.

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Abstract

The future in many engineering areas will belong to software like MATLAB and SIMULINK which are becoming industry standards. MATLAB is a high level language for technical computing which is often used by engineers to help them design systems or analyse a system's behaviour, far more convenient than other languages like C++, FORTRAN et al. SIMULINK is a software package with a graphical user interface for modeling, simulating, and analysing dynamic systems.

The report throws light upon various basic MATLAB commands that are necessary for writing APPROACHs in MATLAB language. It also consists an introductory problem on image processing.

Contents

PROBLEM 1:

1.1-STATEMENT:

A tank system is represented by the following first-order differential equation:

$11.5\frac{dh(t)}{dt}$ +h(t) = q(t)

where h(t) is the liquid level and q(t) is the input flow rate in m3/min.
(a) Develop a Laplace transform model for the system.
(b) Use Simulink to find the response of h(t) to a step change of 1 m3/min, but where there is a slowly varying frequency on the input signal of amplitude 0.1 and frequency 0.05 Hz.

1.2-APPROACH:

```
%laplace transform model
% solving ode by laplace transform
syms stH;
%H laplace transform of h(t)
%Q laplace transform of q(t)
%H1 laplce transform of differentiation of h(t)
%G transfer function
G=tf([1],[11.5 1]);
G
% UNIT STEP RESPONSE
H1=s*H;
q=1;
Q=laplace(q,t,s);
%sol is H(laplace of output)
sol=solve(11.5*H1+H-Q,H);
%insol inversve laplace h(t)
insol=ilaplace(sol,s,t);
insol
sol
ezplot(insol,[0,100]);

% FREQUENCY RESPONSE
q1=0.1*sin(2*pi*0.05*t);
Q1=laplace(q1,t,s);
sol1=solve(11.5*H1+H-Q1,H);
insol1=ilaplace(sol1,s,t);
insol1
sol1
figure;
ezplot(q1,[0,100]);
hold on ;
ezplot(insol1,[0,100]);
```

1.3OUTPUT DATA:

1.3.1

```
%Transfer function:
%   1
%----------
%11.5 s + 1
%insol =
%1-exp(-2/23*t)
%sol =
```

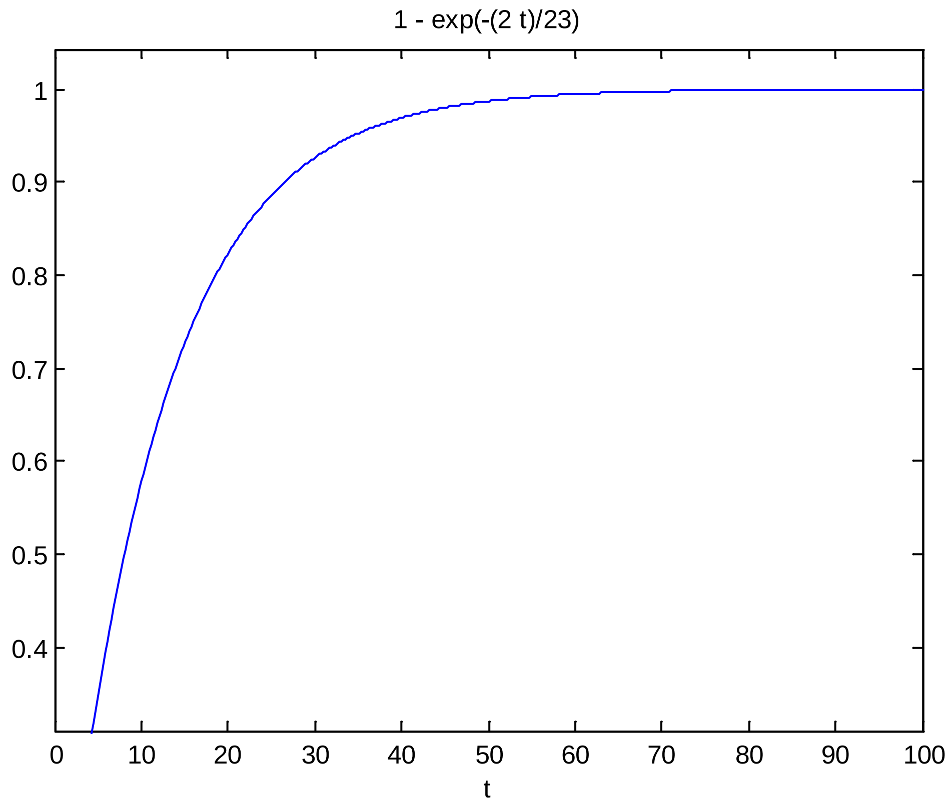
```
%2/s/(23*s+2)
%%%%%%%%%%%%%%%%%%%%%%%
```

1.3.2

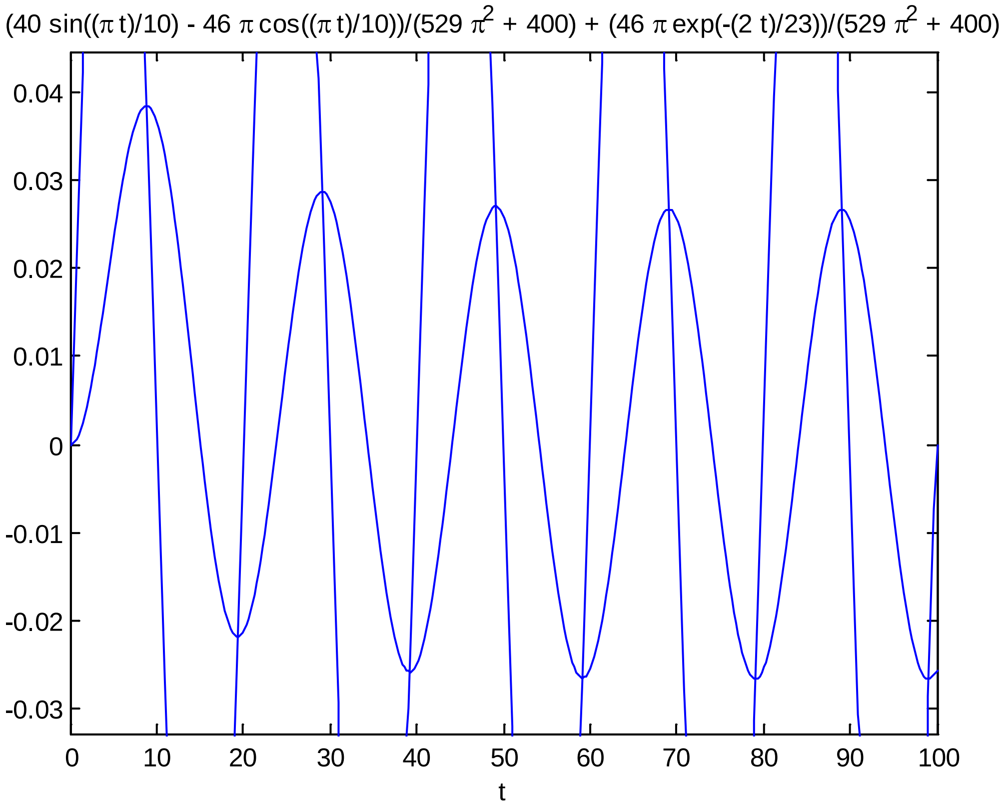
```
% frequency response
%insol1 =

%2*(-23*cos(1/10*pi*t)*pi+20*sin(1/10*pi*t)+23*exp(-
2/23*t)*pi)/(400+529*pi^2)



%sol1 =

%2*pi/(2300*s^3+23*s*pi^2+200*s^2+2*pi^2)
```

1.3 OUTPUT:

1.3.1



1.3.2



OBSERVATION AND COMMENTS:

The question was solved using Simulink where in we used different blocks to represent different parameters, making a loop which represented the Transfer Function and thereby given us the output at the Scope. We observed slowly varying frequency on the input signal to it s affect on the output.

PROBLEM 2:

2.1-STATEMENT:

For each of the second order systems below, plot the step response using SIMULINK. Find *ξ, wn, Ts, Tp, Tr, % overshoot* from the response.

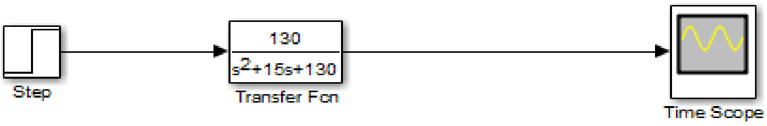
(a) $G(s) = \frac{130}{s^2+15s+130}$

(b) $G(s) = \frac{0.045}{s^2+0.025s+0.045}$

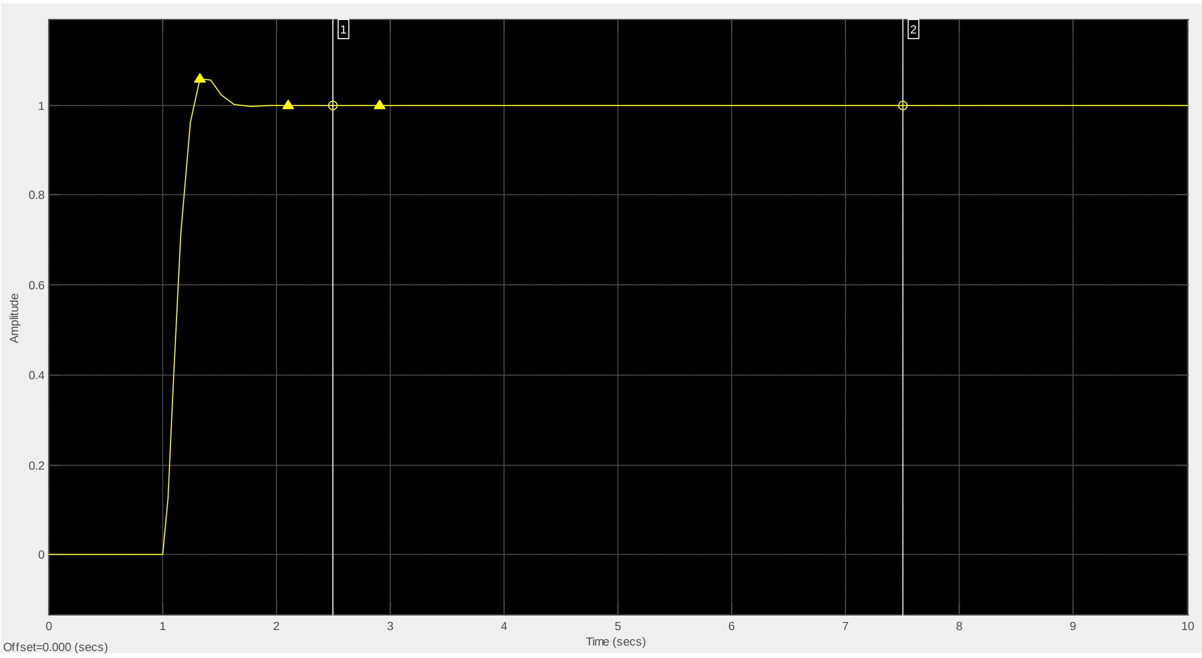
(c) $G(s) = \frac{10^8}{s^2+1.325*10^3 s+10^8}$

2.2-APPROACH:

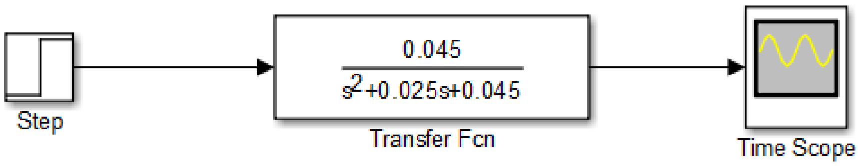
2.2.1



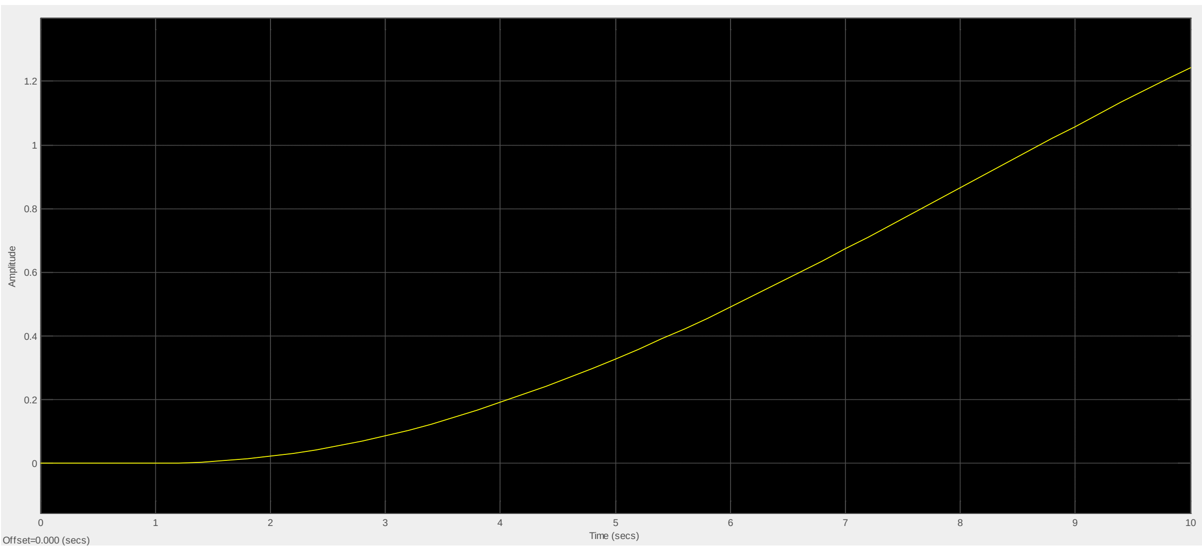
2.3.1 OUTPUT



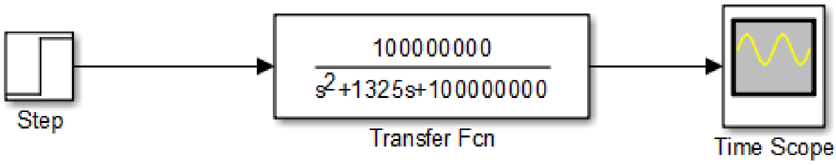
2.2.2


Step
0.045
s2+0.025s+0.045
Transfer Fcn
Time Scope

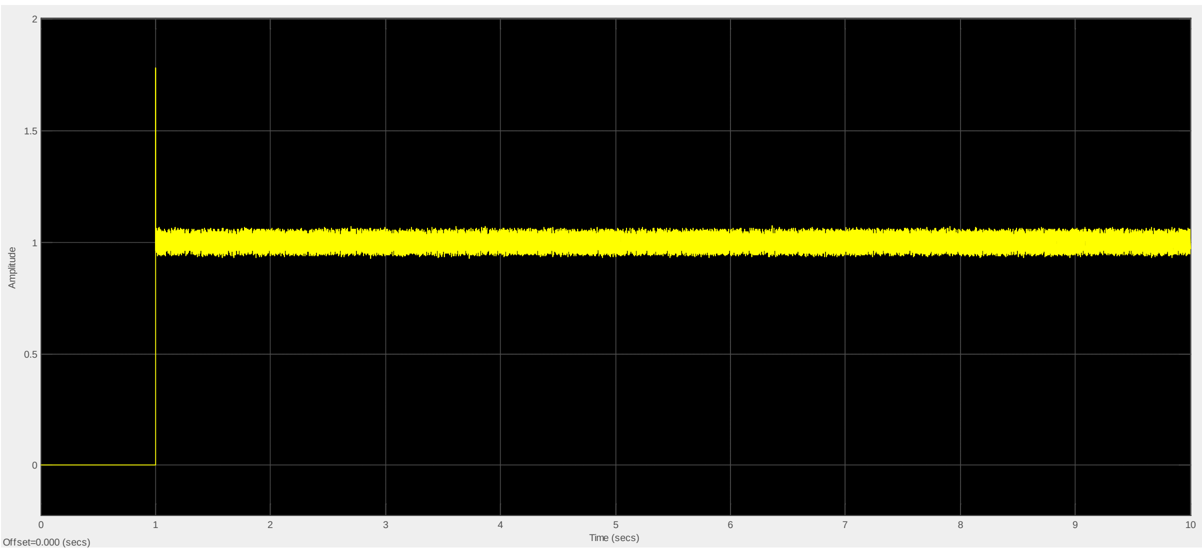
2.3.2


Amplitude
Time (secs)
Offset=0.000 (secs)

2.2.3



2.3.3



OBSERVATION AND COMMENTS:

The question was solved using Simulink where in we used different blocks to represent different parameters, making a loop which represented the Transfer Function and thereby given us the output at the Scope. We observed for each of the second order systems,
ξ, w_n, Ts, Tp, Tr, via MATLAB or SIMULINK

PROBLEM -3:

3.1-STATEMENT:

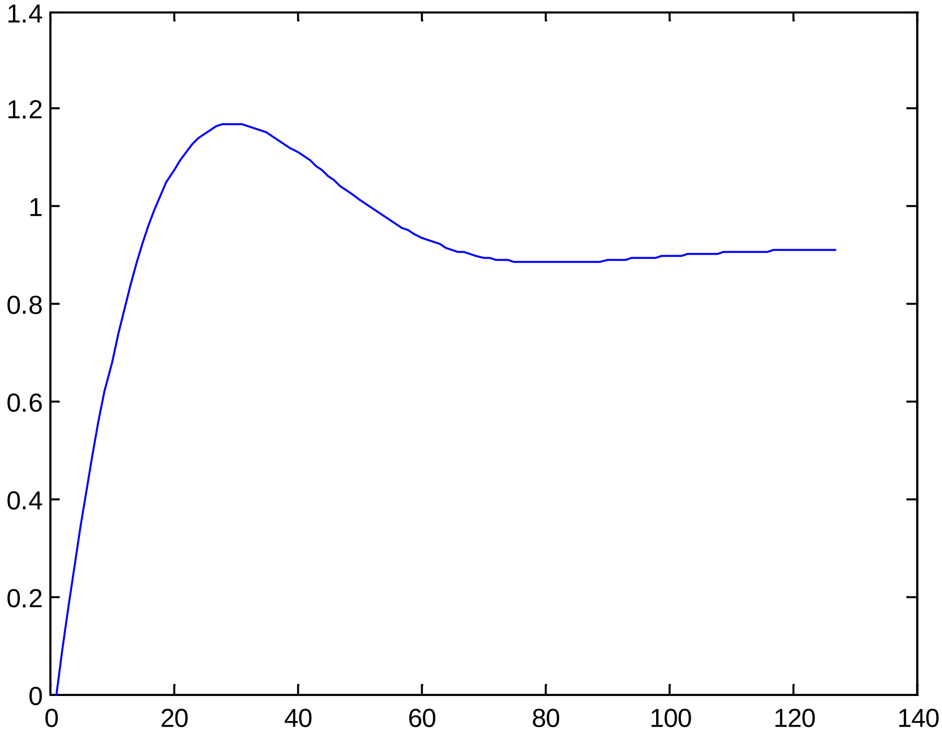
A unity feedback control system has forward path gain $G(s) = \frac{16}{s^2+1.6s}$. A damping ratio of 0.6 is desired through derivative control. Determine the value of derivative time constant Td and compare rise time, peak time, maximum overshoot, settling time (a) without (b) with derivative control.

3.2-APPROACH:

```
%Transfer function without derivative control is H1.
%'y1' is the step response of H1.
%'S1' is the stepinfo of 'y1'.
H1 = tf([16],[1 0 1.6]);
y1 = step(H1);
plot(y1);
S1 = stepinfo(y1);
%disp(S1)

%Transfer function with derivative control is H2 with dampinf ratio of 0.6
derivative time constant of 0.31464 sec.
%'y2' is the step response of 'H2'.
%'S2' is the stepinfo of 'y2'.
H2 = tf([5.03424 16],[1 5.03424 17.6]);
y2 = step(H2);
plot(y2);
S2 = stepinfo(y2);
disp(S2)
```

3.3 OUTPUT

```
%RiseTime: 40
%    SettlingTime: 2.5002e+003
%     SettlingMin: -8.2157e-015
%     SettlingMax: 20.0000
%       Overshoot: 13.8462
%      Undershoot: 2.7714e+017
%            Peak: 20.0000
%        PeakTime: 51

%        RiseTime: 4.6060
%    SettlingTime: 41.7017
%     SettlingMin: 0.8844
%     SettlingMax: 1.1684
%       Overshoot: 28.2207
%      Undershoot: 0
%            Peak: 1.1684
%        PeakTime: 14
```



OBSERVATION AND COMMENTS:

The question was solved using Simulink where in we used different blocks to represent different parameters, making a loop which represented the Transfer Function and thereby given us the output at the Scop. The damping ratio was included in the transfer function by solving on a paper first then modeled onto MATLAB. Setting time with and without derivative control was observed.

PROBLEM -4:

4.1-STATEMENT:

Obtain the pole-zero map of following transfer functions. Also, study Bode plot and

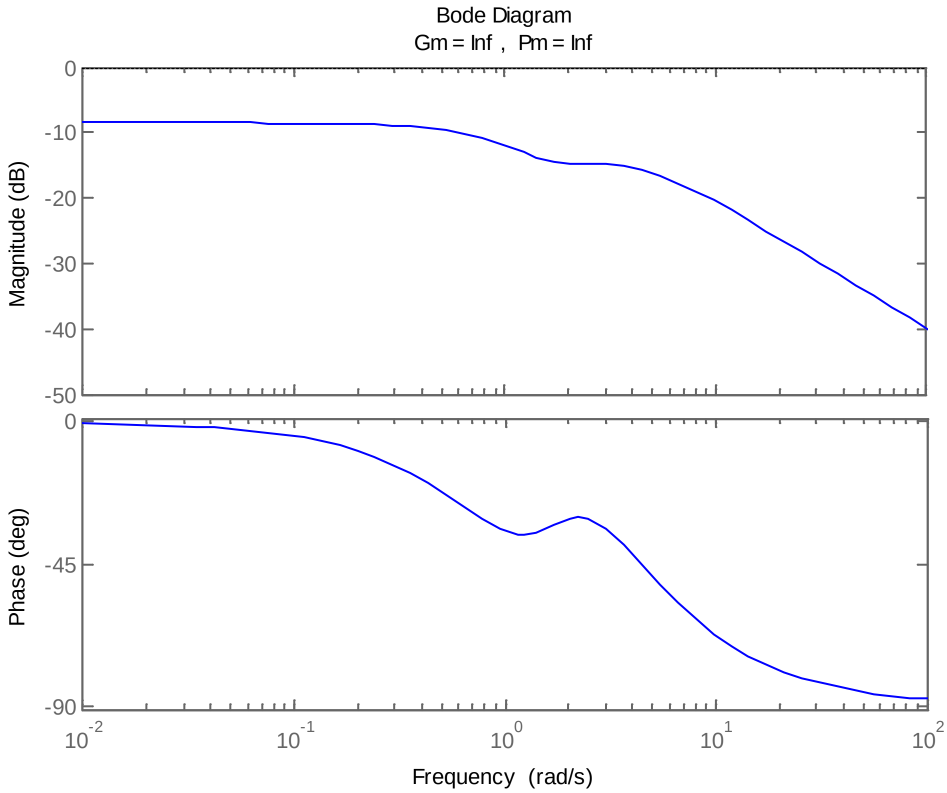
calculate gain and phase margin. Comment on the stability of these systems.

$$F(s) = \frac{s^2+2s+3}{(s+2)^3}, \frac{s^2+8s+6}{s^3+2s^2+3s+4}$$

4.2-APPROACH:

```
%tf1
n1=[1 2 3]
d1=[1 6 12 8]
sys1=tf(n1,d1)
bode(sys1)
grid
margin(sys1)
```

4.3 OUTPUT:



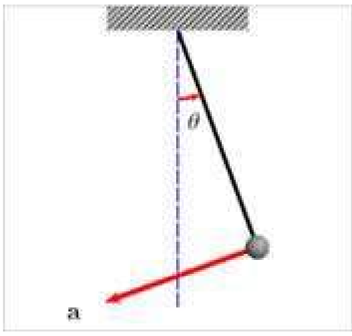
OBSERVATION AND COMMENTS:

The question was solved using Simulink where in we used different blocks to represent different parameters, making a loop which represented the Transfer Function and thereby given us the output at the Scope. The pole zero map was formed, with bode plot and magnitude to observe the stability which can be seen by comparing with the original sognal or by using Root Locus method.

PROBLEM 5:

5.1-STATEMENT:

The pendulum shown in fig:

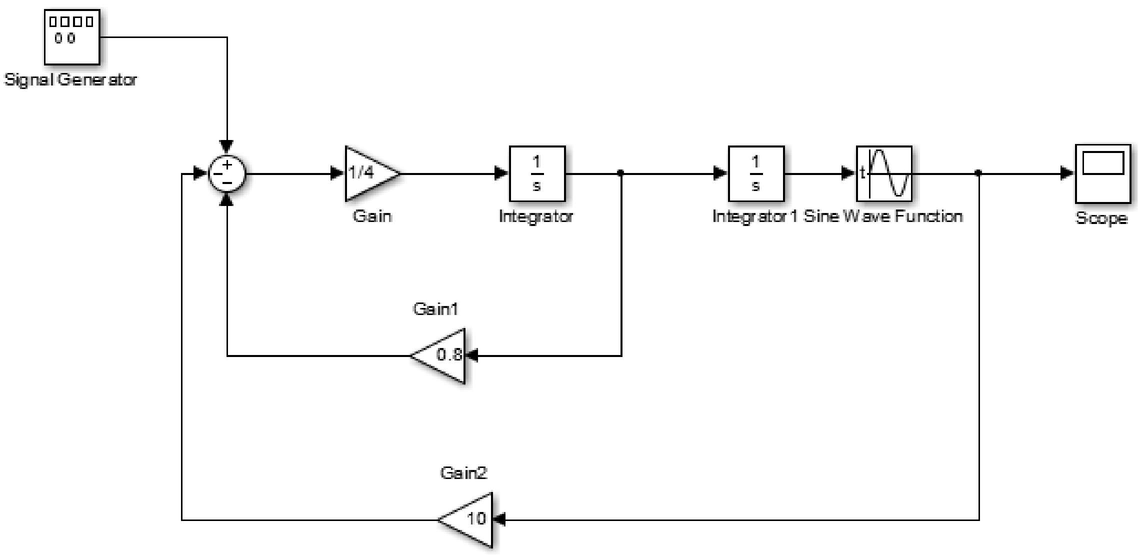


has the following nonlinear equation of motion, if there is viscous friction in the pivot and if there is applied moment M(t) about the pivot.

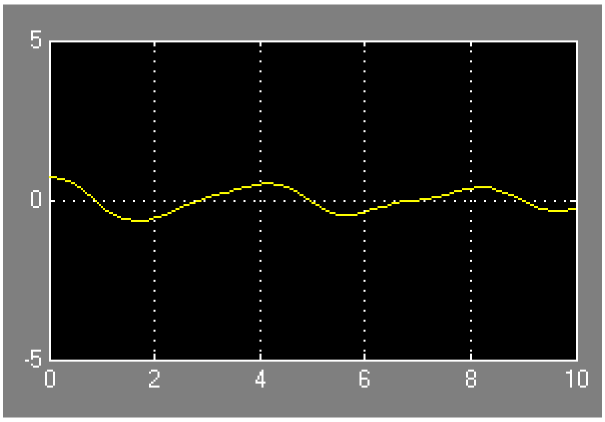
$\frac{Id^2\theta}{dt}$ $+c\frac{d\theta}{dt}$+ $mglsin\theta$=M

Where I is the moment of inertia about the pivot. create the Simulink model for the system where I=4, mgl =10, c=0.8 and M(t) is square wave with the amplitude of 3 and frequency of 0.5 Hz. Assume initial conditions are $\theta(0) = \frac{\pi}{4}rad$ and $\frac{d\theta}{dt}(0) = 0$.

5.2-APPROACH:



5.3-OUTPUT:



OBSERVATION AND COMMENTS:

The question was solved using Simulink where in we used different blocks to represent different parameters, making a loop which represented the Transfer Function and thereby given us the output at the Scope. The challenging part in this question was to form the SIMULINK model, which was a bit different, once made it easily gave us the output.

PROBLEM 7:

7.1-STATEMENT:

A safety bumper is placed at the end of a racetrack to stop out-of-control cars .The bumper is designed in such a way that the force applied is a function of the velocity *v* and the displacement *x* of the front edge of the bumper according to the equation :

$$F = Kv3(x + 1)3$$

where K = 35 s-kg/m5 is a constant.
A car with a mass *m* of 1800 kg hits the bumper at a speed of 60 km/h. Determine and plot the velocity of the car as a function of its position for $0 \le x \le 3$ m.

7.2-APPROACH:

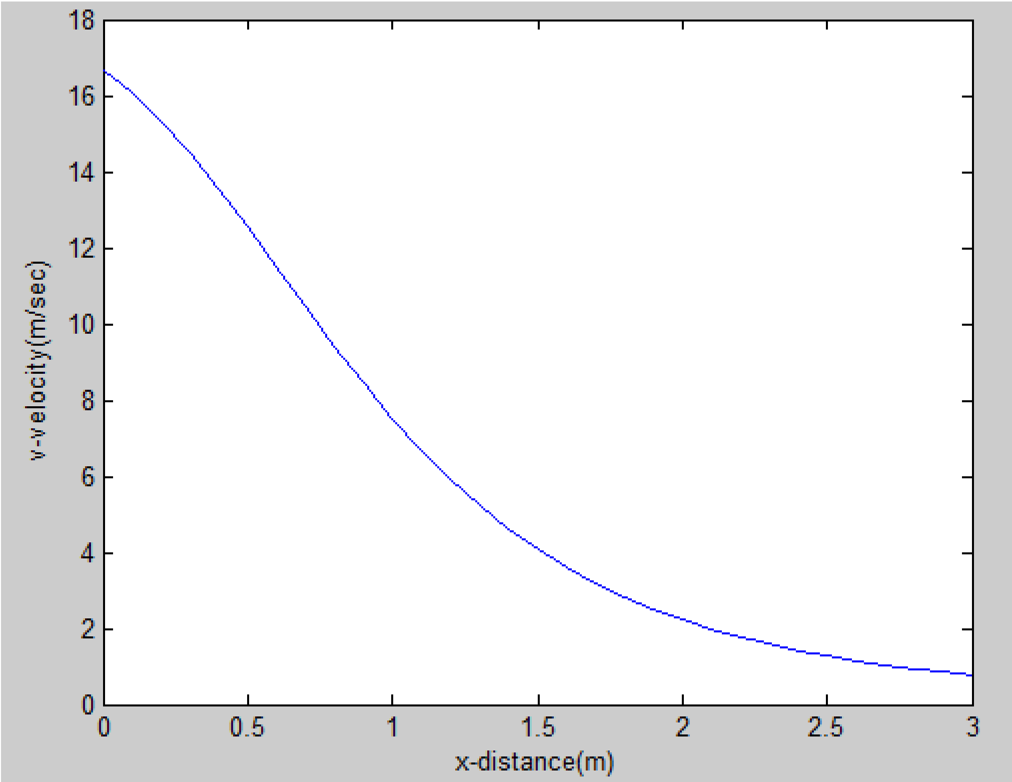
```
% SAFETY BUMPER PROBLEM
% SOLVING USING ODE45
% F=K*v^3*(x+1)^3
% 0<=x<=3 m
% F = m*a = m*v*dv/dx
% Since,car will decelerate so
% dv/dx=-(K*v^2*(x+1)^3)/m
% Also,v0 = 60km/hr at x = 0
% K = 35 s-kg/m^3
% mass of car = m = 1800 kg
v0 = 60*1000/3600; % v0 in m/sec
```

```
K = 35;
m = 1800;
carvelocityode = @(x,v)(-(K*v^2*(x+1)^3)/m);
[x v] = ode45(carvelocityode,[0:0.1:3],v0);
plot(x,v);
xlabel('x-distance(m)'),ylabel('v-(');
```

7.3-OUTPUT:

```
% OUTPUT DATA
%       x        v
%         0   16.6667
%    0.1000   16.0627
%    0.2000   15.3330
%    0.3000   14.4880
%    0.4000   13.5477
%    0.5000   12.5395
%    0.6000   11.4948
%    0.7000   10.4450
%    0.8000    9.4189
%    0.9000    8.4395
%    1.0000    7.5235
%    1.1000    6.6808
%    1.2000    5.9166
%    1.3000    5.2311
%    1.4000    4.6206
%    1.5000    4.0812
%    1.6000    3.6068
%    1.7000    3.1901
%    1.8000    2.8256
%    1.9000    2.5069
%    2.0000    2.2279
%    2.1000    1.9841
%    2.2000    1.7707
%    2.3000    1.5834
%    2.4000    1.4191
%    2.5000    1.2748
%    2.6000    1.1475
%    2.7000    1.0351
%    2.8000    0.9358
%    2.9000    0.8478
%    3.0000    0.7696
```

OUTPUT GRAPH: VELOCITY(V) VS DISTANCE (X)



OBSERVATION AND COMMENTS:

The question was solved using Simulink where in we used different blocks to represent different parameters, making a loop which represented the Transfer Function and thereby given us the output at the Scope. The challenging part was to calculate the equations and writing them in the correct form to represent in a T.F. so that it could be easily made

PROBLEM 8:

8.1-STATEMENT:

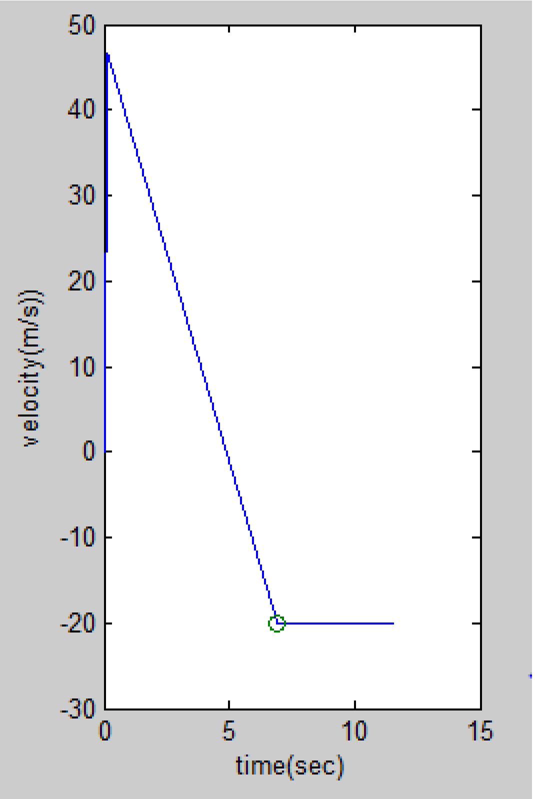
The flight of a model rocket can be developed as follows. During the first 0.15 s the rocket is propelled up by the rocket engine with a force of 16 N. The rocket then flies up while slowing down under the force of gravity. After it reaches its peak, the rocket starts to fall back. When its down velocity reaches 20 m/s a parachute opens (assumed to open instantly) and the rocket continues to move down at a constant speed of 20 m/s until it hits the ground. Write a program that calculates and plots the speed and altitude of the rocket as a function of time during the flight.

8.2-APPROACH:

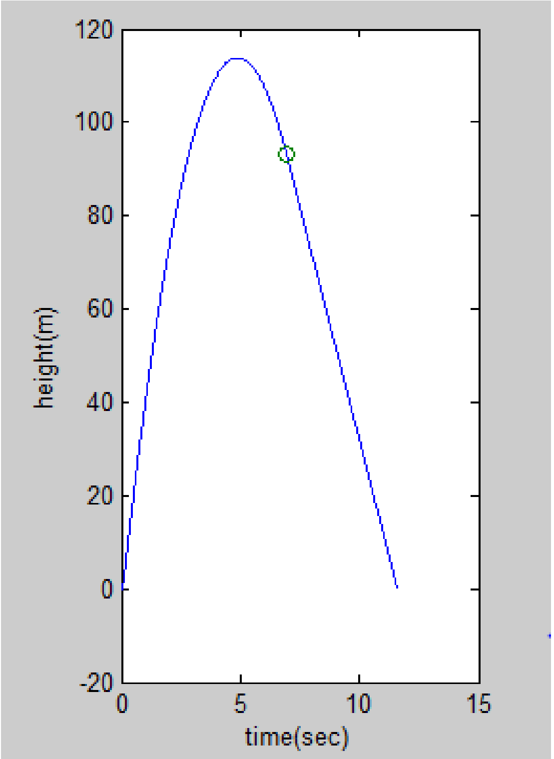
```
m=0.05; g=9.81; tEngine=0.15; Force=16; vc=-20; Dt=0.01;
clear t v h
n=1;
t(n)=0; v(n)=0; h(n)=0;
% Segment 1
a1=(Force-m*g)/m;
while t(n) < tEngine & n < 50000
n=n+1;
t(n)=t(n-1)+Dt;
v(n)=a1*t(n);
h(n)=0.5*a1*t(n)^2;
end
v1=v(n); h1=h(n); t1=t(n);
% Segment 2
while v(n) >= vc & n < 50000
n=n+1;
t(n)=t(n-1)+Dt;
v(n)=v1-g*(t(n)-t1);
h(n)=h1+v1*(t(n)-t1)-0.5*g*(t(n)-t1)^2;
end
v2=v(n); h2=h(n); t2=t(n);
% Segment 3
while h(n) > 0 & n < 50000
n=n+1;
t(n)=t(n-1)+Dt;
v(n)=vc;
h(n)=h2+vc*(t(n)-t2);
end
subplot(1,2,1)
plot(t,h,t2,h2,'o')
subplot(1,2,2)
plot(t,v,t2,v2,'o')
```

8.3-OUTPUT

(a) Time vs. velocity



(b) Time vs. Height



OBSERVATION AND COMMENTS:

The question was solved using Simulink where in we used different blocks to represent different parameters, making a loop which represented the Transfer Function and thereby given us the output at the Scope. The interesting part about this question was it made us use kinematics into MATLAB, we used basic laws and formed the equations which were easily used in matlab to obtain the output.

PROBLEM -9:

9.1-STATEMENT:

From electric circuit theory, it is known that charging a capacitor with a constant current produces a linear voltage across it, that is,V_C=(I/C)*t
where C is the capacitance in farads, I is the constant current through the capacitor I in amperes, and Vc is the linear voltage across the capacitor in volts. Using aVariable Transport Delay block create a model to display the output if I = 2 mA, C= 1000 μF, and the voltage across the capacitor at some time t0 is V0= 2v.

9.2-APPROACH:

V_C=(I/C)*t

V_C : LINEAR VOLTAGE ACROSS CAPACITOR

C : CAPACITANCE=1000µf

I: CONSTANT CHARGING CURRENT=2Ma

t : TIME(sec)

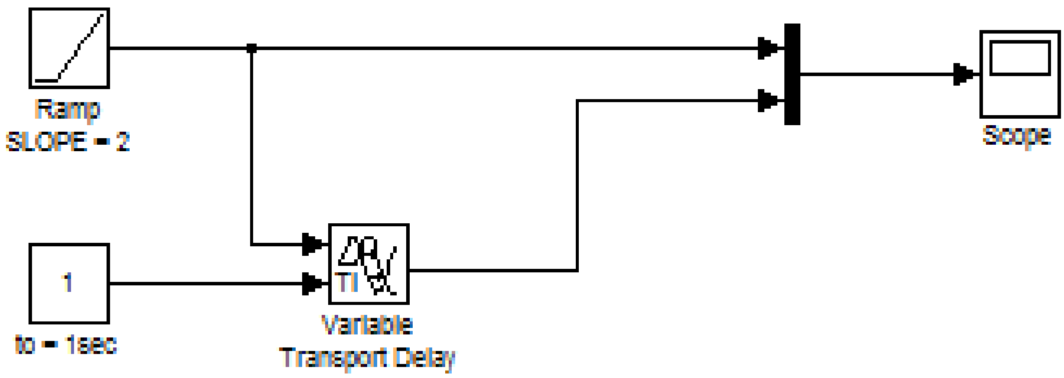
V_0 : VOLTAGE ACROSS CAPACITOR AT TIME t_0 =2V

CALCULATIONS:

I/C=2V=SLOPE

t_0=V_0/SLOPE =1sec

9.3-OUTPUT:



OBSERVATION AND COMMENTS:

The question was solved using Simulink where in we used different blocks to represent different parameters, making a loop which represented the Transfer Function and thereby given us the output at the Scope. This question got into how T.F. is used in electric circuit and we had to form a Variable Transport Delay block. The output was displayed on the scope showing us the effect of specific values of C,F and all.

Problem 10:

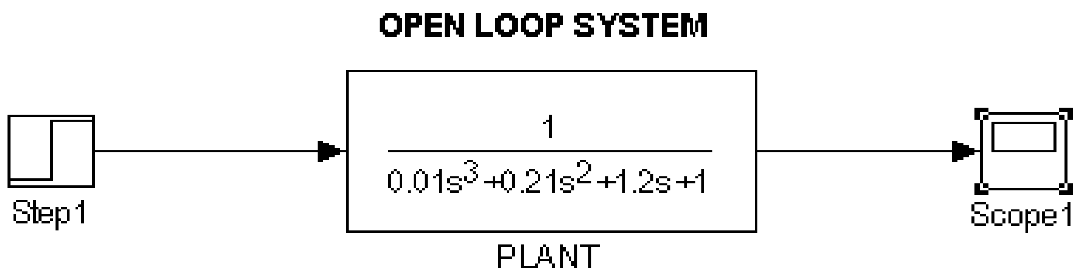
10.1-APPROACH:

Tuning of PID controller with Ziegler-Nicholas method for the following plant for step response.

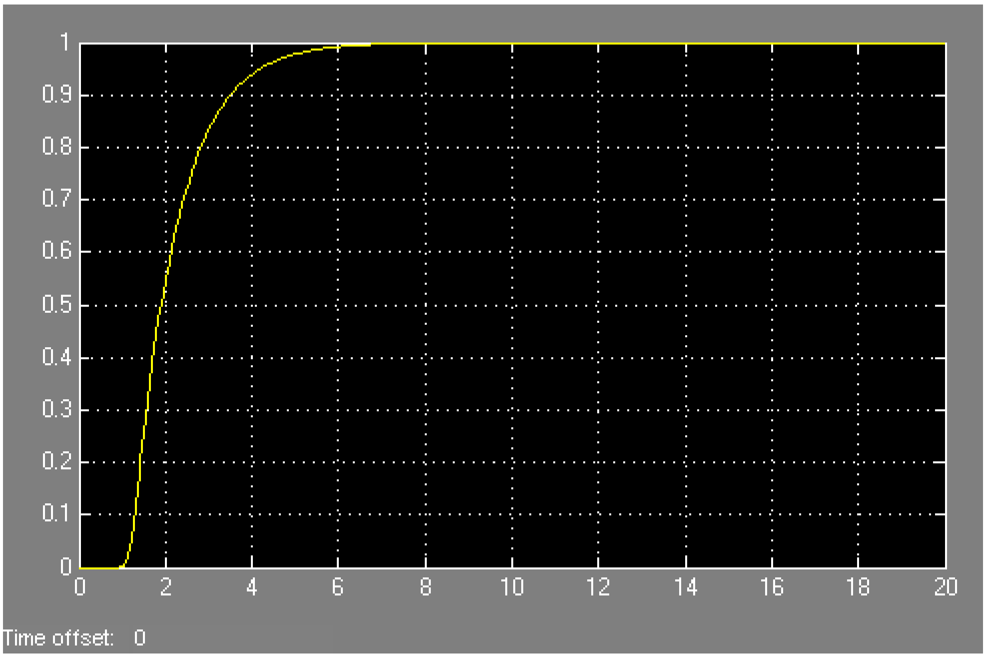
$$G(s) = \frac{1}{(s+1)(1+0.1s)^2}$$

The Ziegler–Nichols tuning method is a heuristic method of tuning PID controllers.
It is performed by setting the I (integral) and D (derivative) gains to zero. The "P" (proportional) gain, K_p is then increased (from zero) until it reaches the ultimate gain K_u, at which the output of the control loop oscillates with a constant amplitude. K_u and the oscillation period T_u are used to set the P, I, and D gains depending on the type of controller used.

When the system is an open loop system:



10.3 OUTPUT:



Zeigler-Nicholas tuning for close loop system:

STEP:1 To find value of Kp at which system is on verge of instability.

$$K_p = K_u$$

Where,

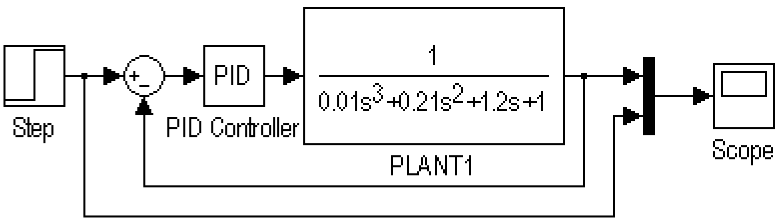
K_u: Ultimate Gain

- K_u=24.197(By Calculation) at ω=10.954rad/sec(Calculated)

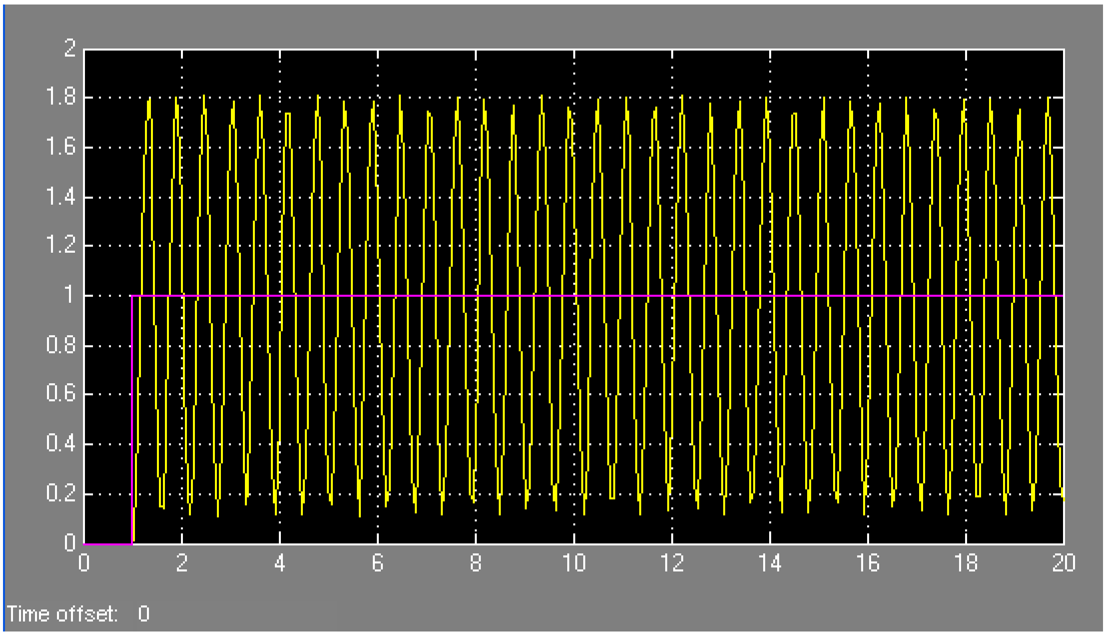
P_u: Ultimate period of oscillation

- P_u = 2*π/ω =0.573sec(Calculated)

- $K_u(K_p)$=24.197(sustained oscillations)



OUTPUT:



STEP:2 Ziegler Nicholas Rules

P:K_p=0.5*Ku
PI: K_p= 0.45Ku T_I=P_u/1.2
PID: K_p=0.6*Ku T_D = P_u/8 T_I=P_u/2

- $K_I = K_p/T_I$
- $K_D = K_p * T_D$

For P Control System:

- FINAL VALUES OF K_p (P CONTROL) = 12.098

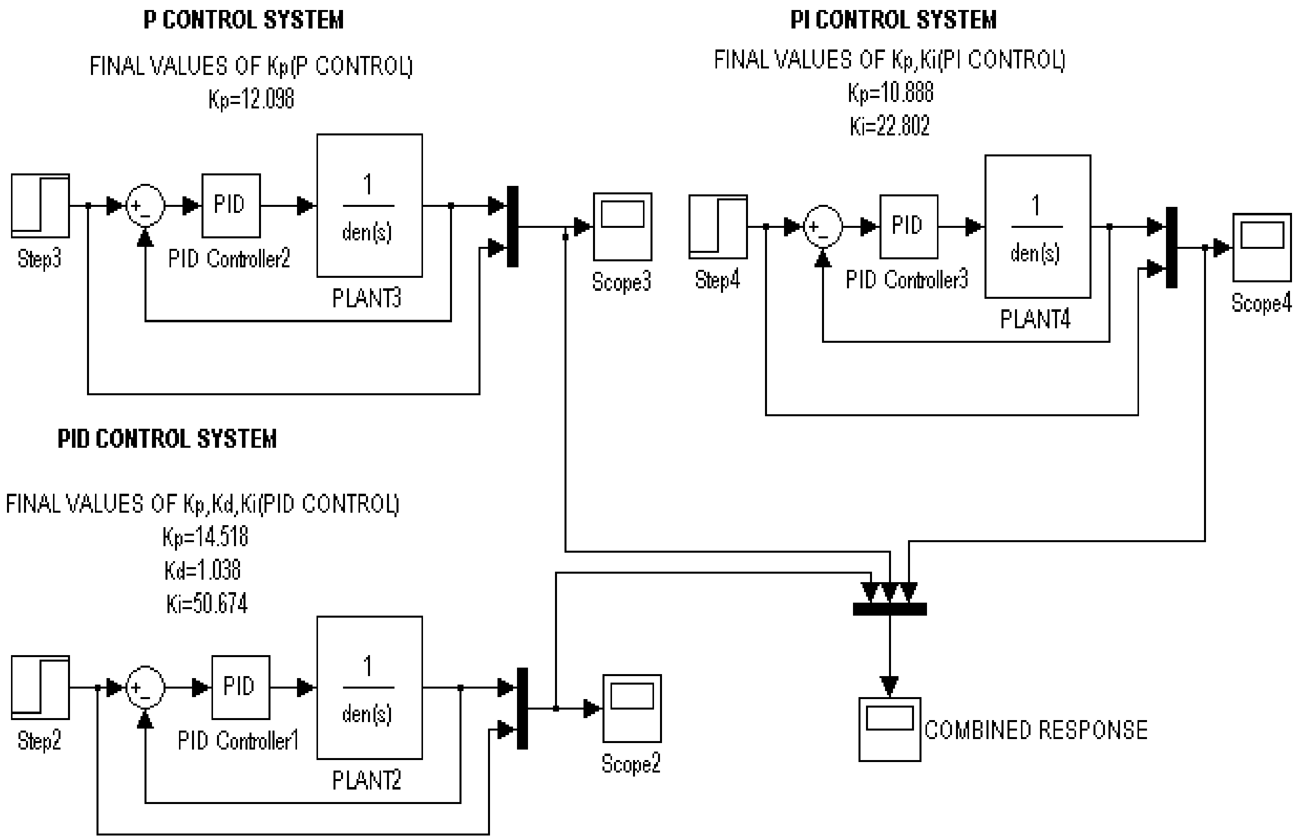
For PI Control System:

- FINAL VALUES OF K_p & K_I (PI CONTROL)

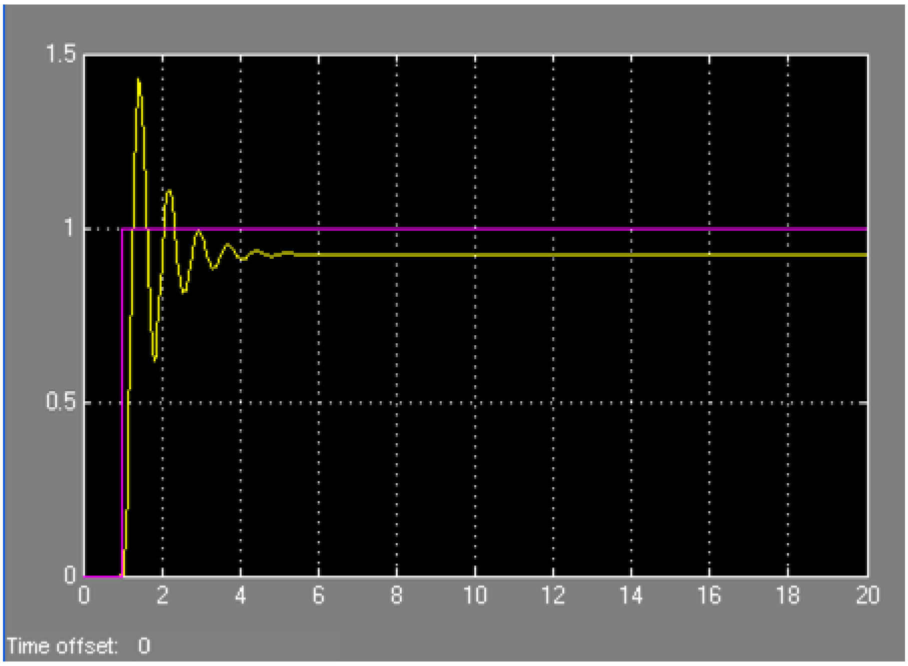
K_p=10.888
K_I=22.802

For PID Control System:

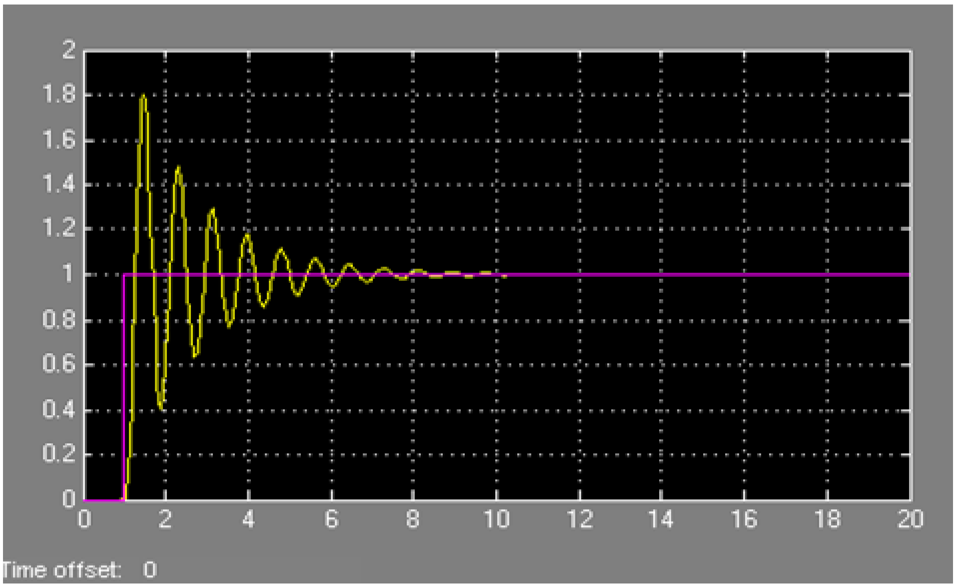
- FINAL VALUES OF K_p,K_D&K_I (PID CONTROL)
  K_p = 14.518
  K_D = 1.038
  K_I = 50.674



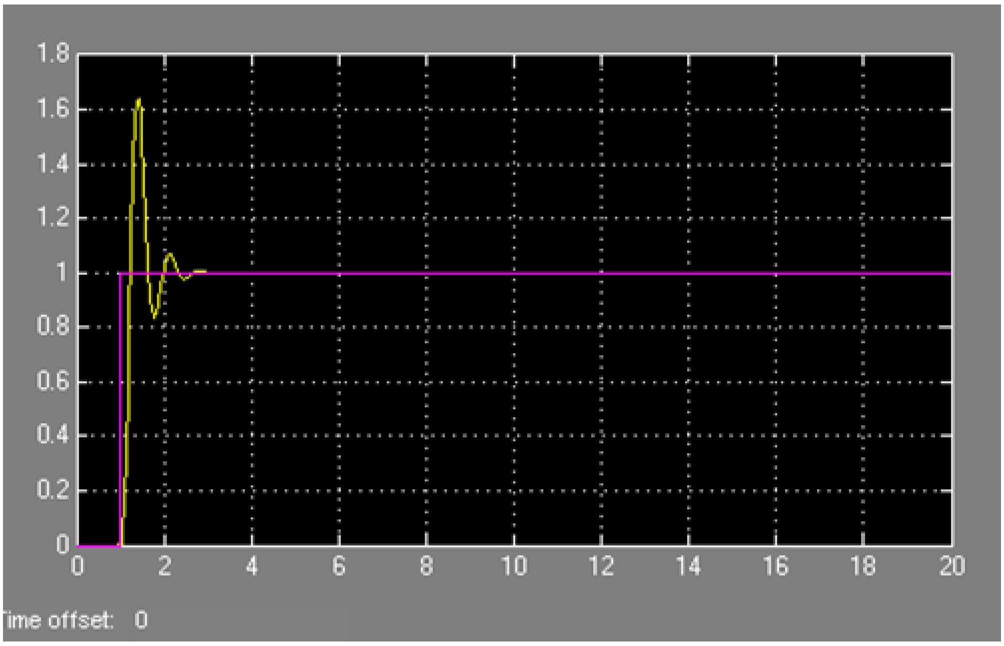
OUTPUT: **P Control System**



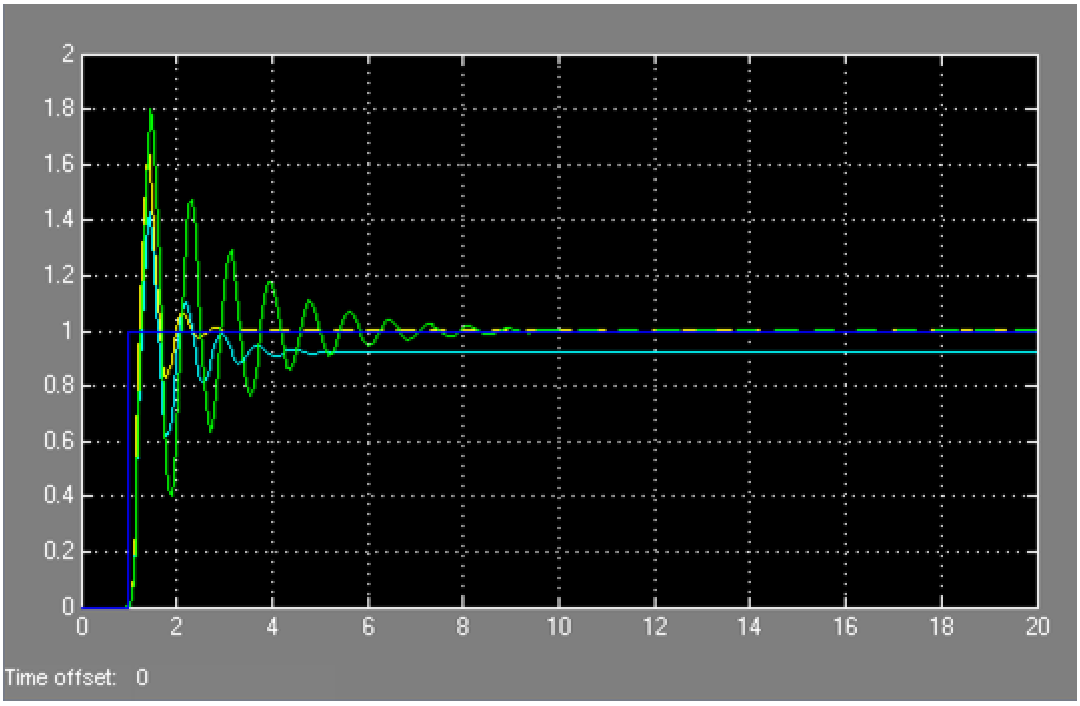
PI Control System



PID Control System



Combined Output



OBSERVATION AND COMMENTS:

The question was solved using Simulink where in we used different blocks to represent different parameters, making a loop which represented the Transfer Function and thereby given us the output at the Scope. This question used a very helpful tool called PID- Proportional Integrator Differentiator. This question was tough we used google and youtube to understand it.

PROBLEM 11:

11.1-STATEMENT:

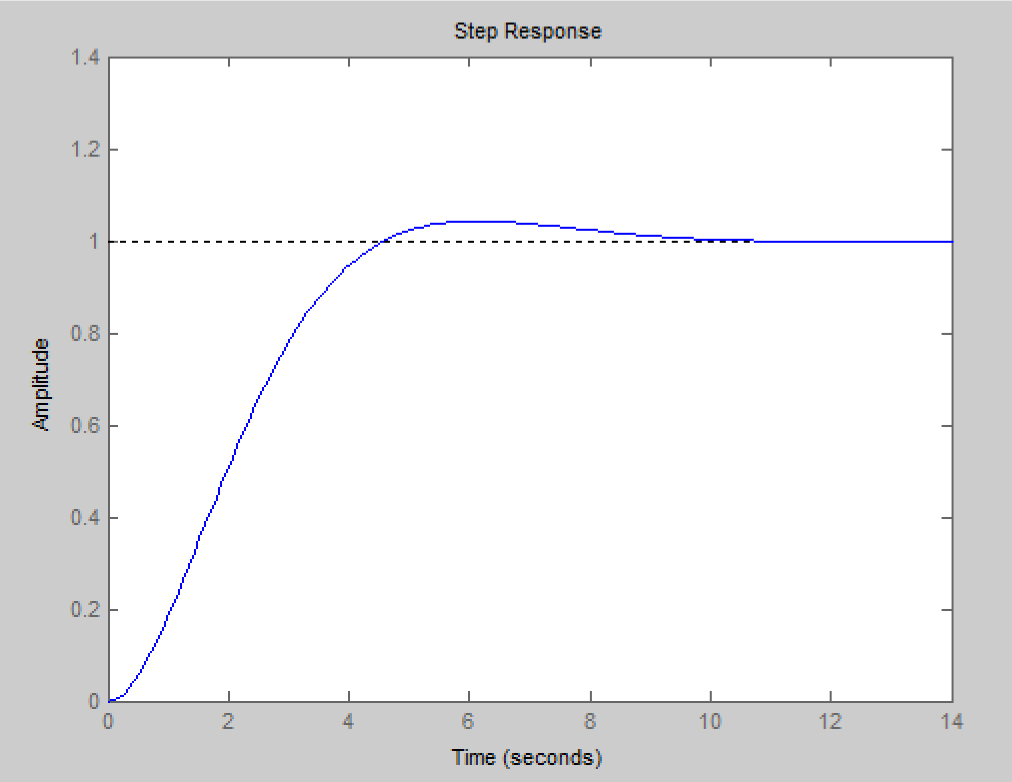
It is known that the transfer function of a system is
Use the bilinear transformation to convert this transfer function to the Z-transform equivalent, and create a model showing the waveforms of both the step response in the s−domain and in the z-domain

11.2-APPROACH:

```
% Step response in s domain
num=0.5279;
den=[1 1.0275 0.5279];
G=tf(num,den);
step(G);
% Step response in z domain
% BILINEAR TRANSFORMATION
%Ts = sampling time
Ts=0.05;
% BY BILINEAR TRANSFORMATION
VERS=1;
METHOD='S_Tust';
AUG=[Ts 1];
% STATE SPACE CONVERSION METHOD 1
% a=[0.5279];
% b=[1 1.0275 0.5279];
% [A,B,C,D]=tf2ss(a,b);
% G1=ss(A,B,C,D);
% STATE SPACE CONVERSION METHOD 2
G1=ss(G);
Gz = bilin(G1,VERS,METHOD,AUG);
figure
step(Gz);
```

11.3-RESULTS:

Graph: Amplitude vs Time



OBSERVATION AND COMMENTS:

The question was solved using Simulink where in we used different blocks to represent different parameters, making a loop which represented the Transfer Function and thereby given us the output at the Scope. We used bilinear transformation to convert this T.F. to the Z transform which was used in MATLAB which has pre fed method for Z transform.

PROBLEM 12:

12.1-STATEMENT:

The price of a particular security (stock) over a 10-day period is as follows:
12 18 16 15 17 18 20 18 19 14
where the last value is the most recent. Create a model for the moving average sequence n-k+1 with k =4.

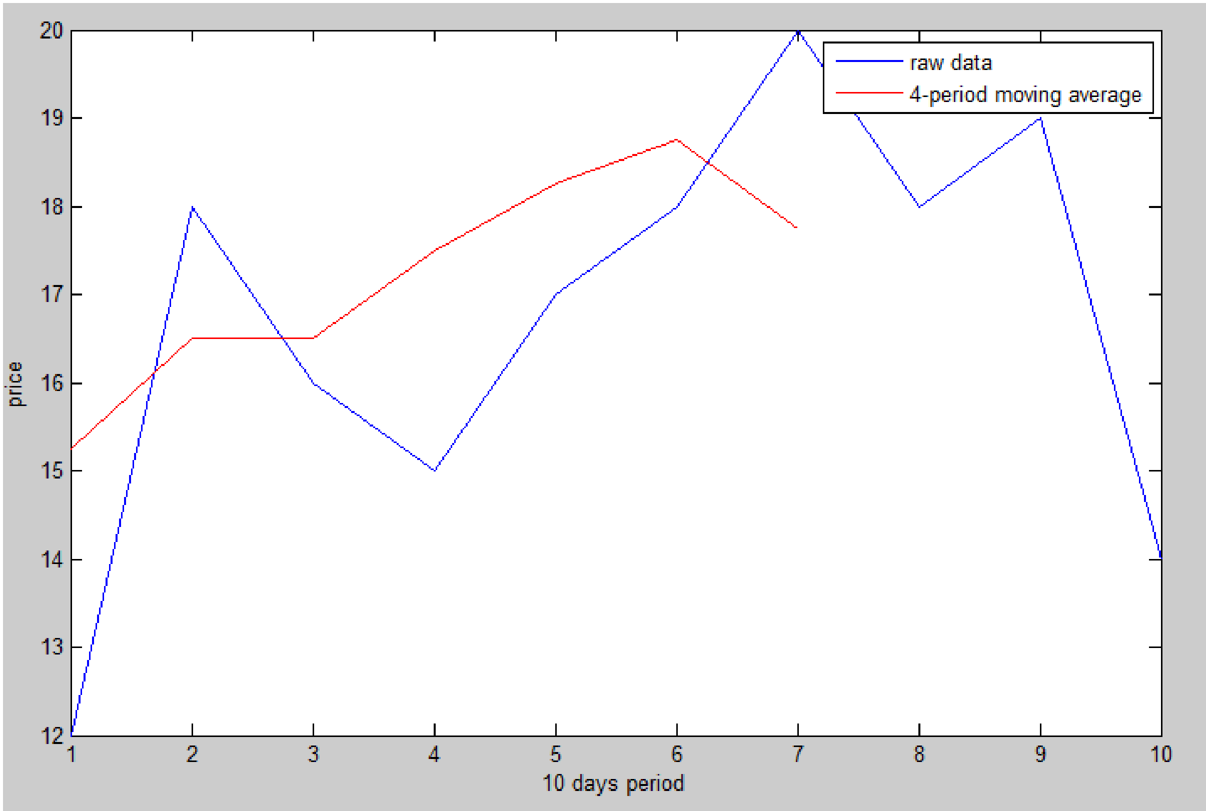
12.2-APPROACH:

```
%Moving Average with period of 4
%x=[12,18,16,15,17,18,20,18,19,14];
x=input('Enter the price of particular security(stock) within ''[]'': ' );
k=input('Enter the moving average period : ');
n=length(x);
```

```
n
j=1;
n-k+1
for i=1:(n-k+1)

    s(j)=(x(i)+x(i+1)+x(i+2)+x(i+3))/4;
   j=j+1;
end
  i=1:n;
  plot(i,x)
  hold on
  i=1:(n-k+1);
  s(i)
  plot(i,s(i),'r')
```

12.3-OUTPUT:

```
 %OUTPUT
%Enter the price of particular security(stock) within '[]': [12 18 16 15 17
18 20 18 19 14]
%Enter the moving average period : 4
%n = 10

%ans = 7
%ans = 15.2500   16.5000   16.5000   17.5000   18.2500   18.7500   17.7500
```



OBSERVATION AND COMMENTS:

The question was solved using Simulink where in we used different blocks to represent different parameters, making a loop which represented the Transfer Function and thereby given us the output at the Scope. The moving average method demanded a bit of programming which was challenging at first, but the process made us understand the use of Z transform.

PROBLEM 13:

13.1-STATEMENT:

Obtain the unit-step response and unit-ramp response of the following system using MATLAB.

$$\begin{bmatrix} x1' \\ x2' \\ x3' \end{bmatrix} = \begin{bmatrix} -5 & -25 & -5 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} x1 \\ x2 \\ x3 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} u$$

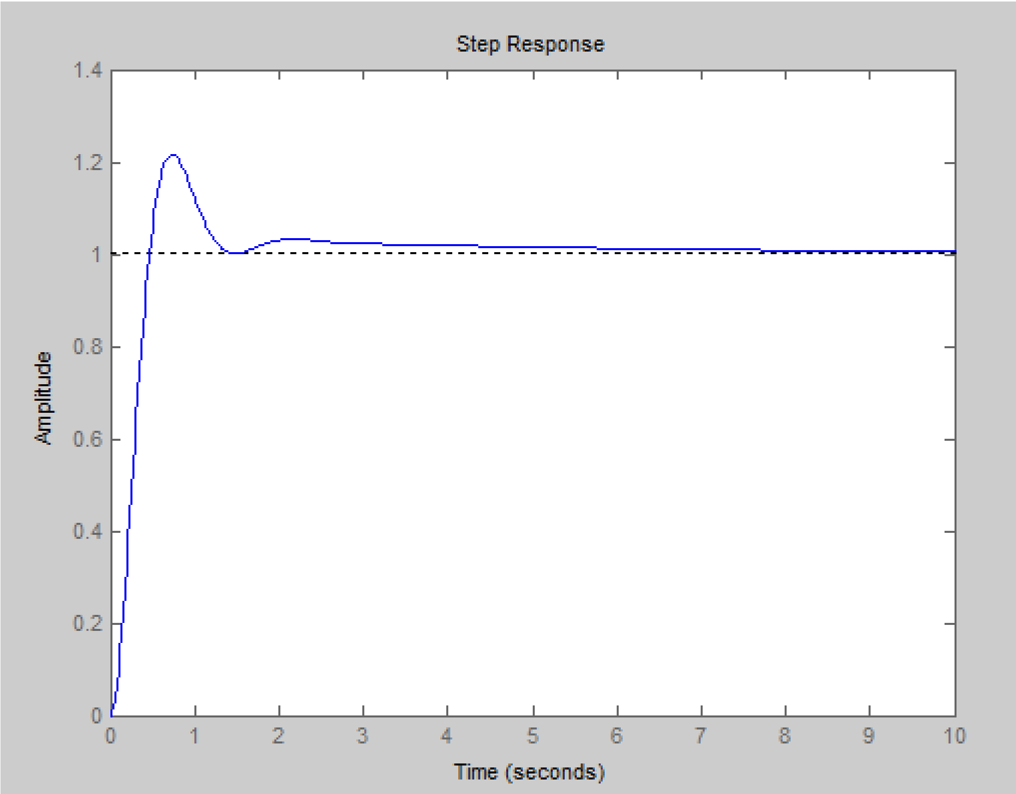
$$Y = \begin{bmatrix} 0 & 25 & 5 \end{bmatrix} \begin{bmatrix} x1 \\ x2 \\ x3 \end{bmatrix} + [0]u$$

13.2-APPROACH:

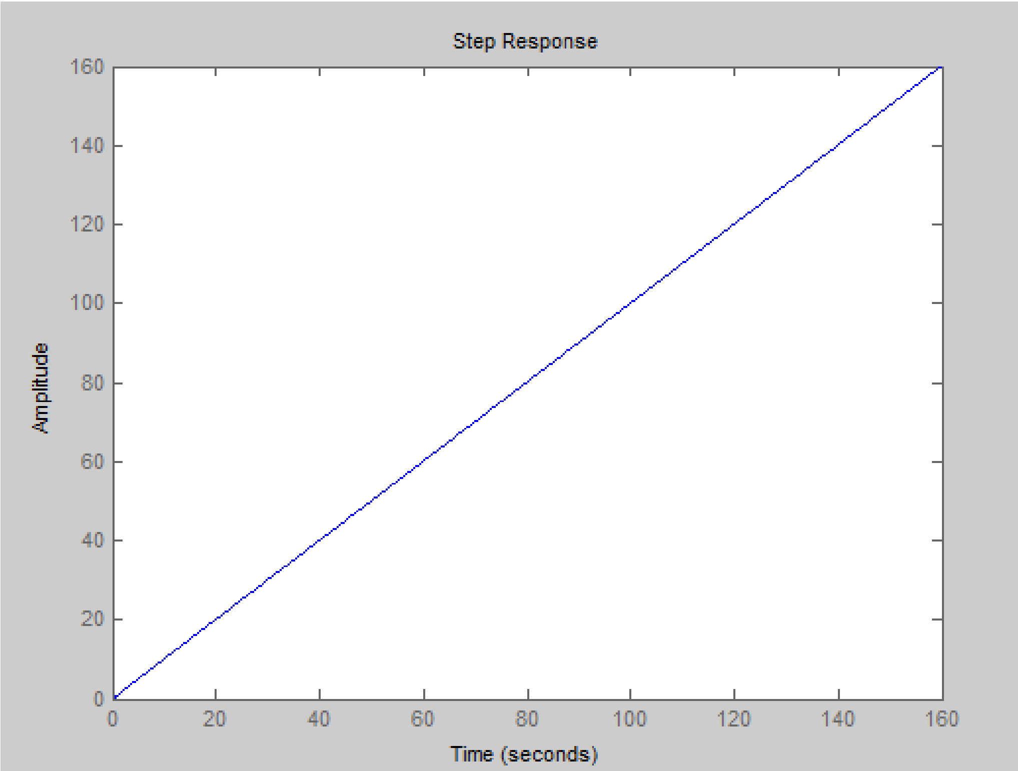
```
% STEP RESPONSE OF GIVEN STATE SPACE SYSTEM
% INPUT : u(t)
% OUTPUT : y(t)
% DEFINING MATRICES A,B,C,D
A=[-5 -25 -5;1 0 0;0 1 0];
B=[1;0;0];
C=[0 25 5];
D=0;
% STATE SPACE TO TRANSFER FUNCTION TRANSFORMATION
[n,d]=ss2tf(A,B,C,D);
% H : TRANSFER FUNCTION
H=tf(n,d)
% OUTPUT TRANSFER FUNCTION
% Transfer function:
% -2.665e-015 s^2 + 25 s + 5
% -------------------------
%   s^3 + 5 s^2 + 25 s + 5
 step(H);
 % RAMP RESPONSE
 s=tf('s');
 s
 figure;
 step(H/s);
```

13.3-RESULTS:

STEP RESPONSE



RAMP RESPONSE



OBSERVATION AND COMMENTS:

The question was solved using MATLAB where in we used different blocks to represent different parameters, making a loop which represented the Transfer Function and thereby given us the output at the Scope. The unit step response and unit rampn response were observed where in we saw the output graph and used MATALB to obtain it.

PROBLEM 14:

14.1-STATEMENT:

Consider the differential equation system given by

y”=4y+3y’=0; y(0)=0.2; y’(0)=0.1

Find the state space equation for the system. Also, obtain the response *y(t)* of the system subject to the given initial conditions.

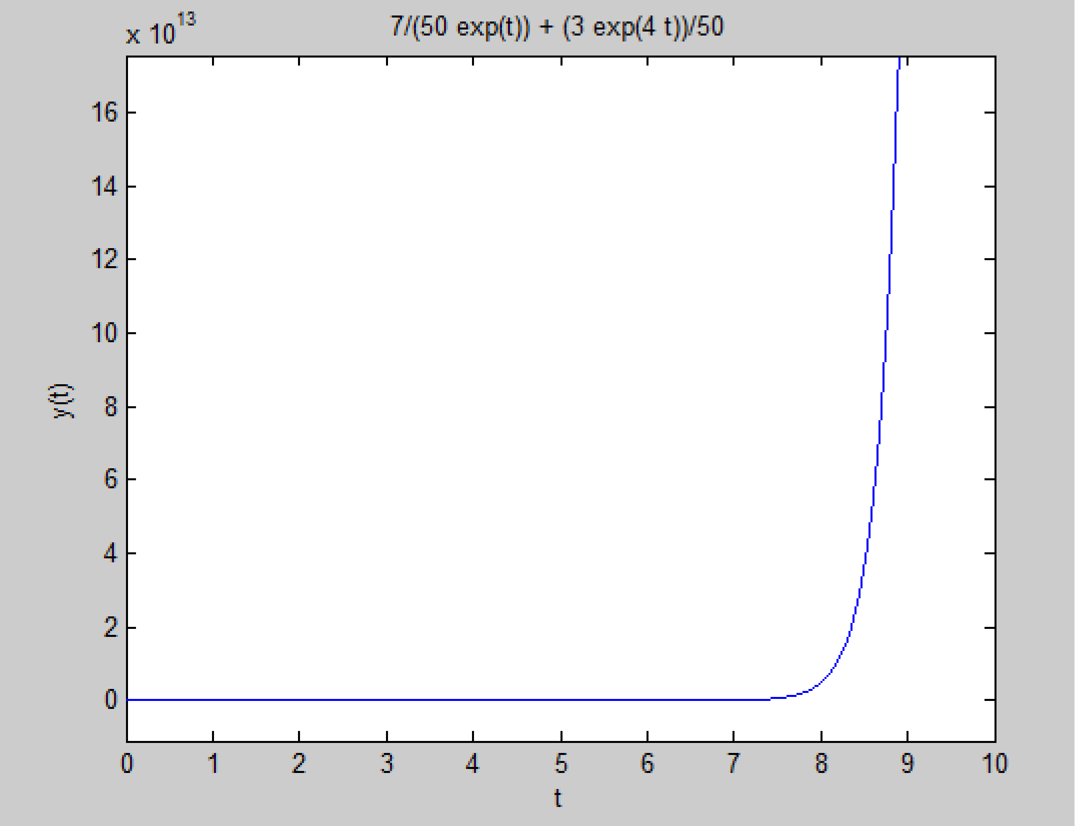
14.2-APPROACH:

```
% RESPONSE OF y(t) DUE TO INITIAL CONDITIONS
% y''=4y+3y'; y(0)=0.2; y'(0)=0.1
r= dsolve('D2y=4*y+3*Dy','y(0)=0.2','Dy(0)=0.1');
```

```
r
t=0:0.1:10;
ezplot(r,t);
xlabel('t');
ylabel('y(t)');
% OUTPUT
% r =
% 3/50*exp(4*t)+7/50*exp(-t)
```

14.3-RESULTS:

Graph: y(t)(response) vs time(t)



OBSERVATION AND COMMENTS:

The question was solved using MATLAB where in we used different codes to represent different parameters, making a loop which represented the Transfer Function and thereby given us the output. The question needed us to solve state space equations there by the output was observed as increasing function .

PROBLEM 15:

15.1-STATEMENT:

In a bandpass filter, the lower and upper cut off frequencies are f1 = 2Hz and f2 = 6Hz respectively. Compute the 1 Ω energy of the input, and the percentage that appears at the output, if the input signal is $v_{in}(t)= 3e^{-2t}u_o(t)$ volts.

15.2-APPROACH:

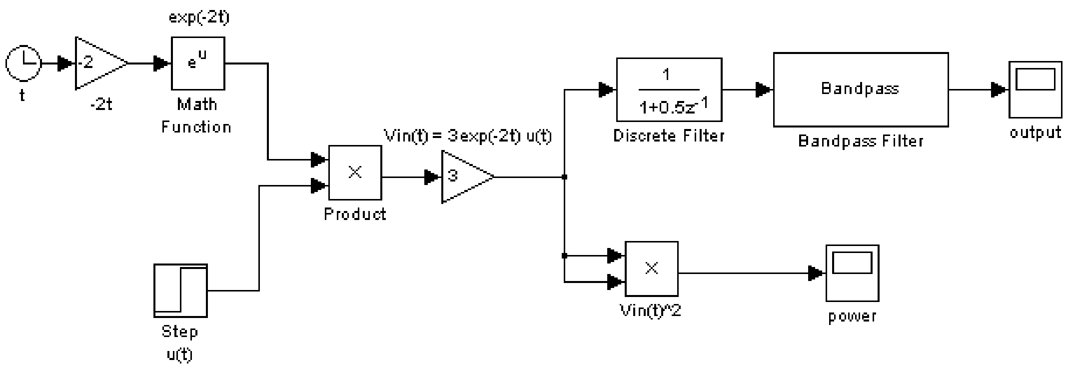
The lower and upper cut-off frequencies of the bandpass filter are given as:

f_1(lower cut-off frequency) = 2 Hz
f_2(upper cut-off frequency) = 6 Hz

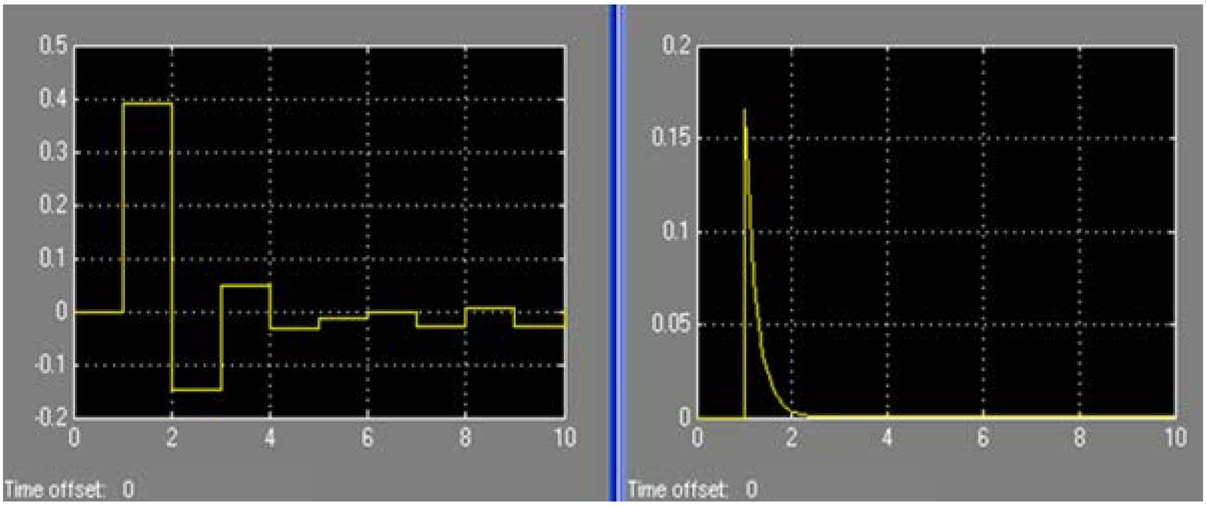
Input signal is given as

$$v_{in}(t) = 3e^{-2t}u_0(t)\ volts$$

SIMULINK MODEL:



OUTPUT:



OBSERVATIONS AND COMMENTS

The question was solved using Simulink where in we used different blocks to represent different parameters, making a loop which represented the Transfer Function and thereby given us the output at the Scope. The simulink blocks were formed in accordance with the filters, the lower and upper cut of frequencies where kept in mind and graphs were observed.

PROBLEM 16:

16.1-STATEMENT:

A discrete time system is described by differential equation

y[n] + y[n-1] = x[n]

where

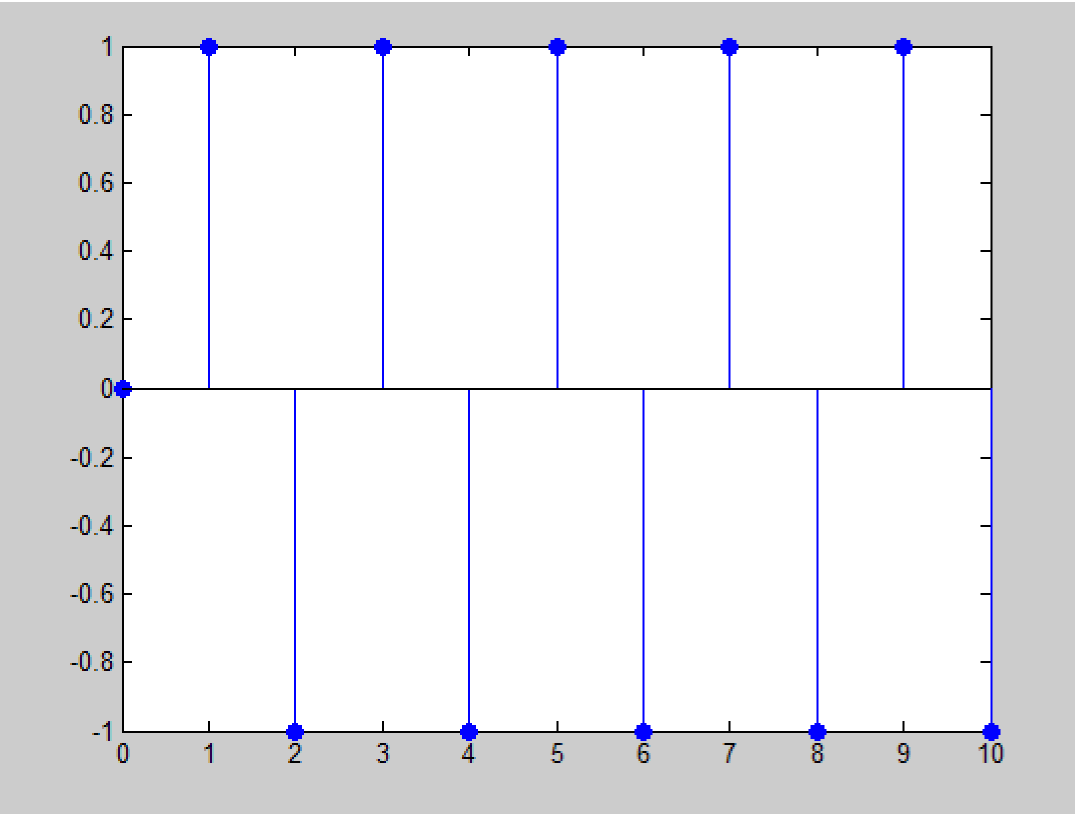
y[n]=0 *for n<0.*

16.2- APPROACH:

```
% DISCRETE TIME SYSTEMS
% COMPUTING TRANSFER FUNCTION H(z)
% y[n]+y[n-1]=x[n]

n=0:10;
num=[1];
den=[1 1];
H=filt(num,den);
H
% OUTPUT
```

```
%Transfer function:
%   1
%--------
%1 + z^-1

% STEP RESPONSE x[n]=10;n>=0
y=10*dstep(num,den,length(n));
stem(n,y,'fill');
%y

%IMPULSE RESPONSE:h
h=dimpulse(num,den,length(n));
figure;
%h
stem(n,h,'fill');
```

16.3-RESULT:



OBSERVATION AND COMMENTS:

The question was solved using MATLAB where in we used different codes to represent different parameters, making a loop which represented the Transfer Function and thereby given us the output. MATLAB made it easy to understand the impulse response with responses in the range specified .

Conclusion

MATLAB is used for various purposes such as image processing, control systems, measurement, computational finance and signal processing. MATLAB is one of the most widespread application used by many technical industries and engineers.

Various other approaches in MATLAB such as Simulink provided block libraries that is customizable, graphical editor and modelling solvers and dynamic system simulation. It is integrated with MATLAB®, enabling you to incorporate MATLAB algorithms into models and export simulation results to MATLAB for further analysis.

Bibliography

1. Analysis and Design of Control System Using MATLAB by Rao V. Dukkipati
2. Introduction to Simulink with Engineering Applications by Steven T. Karris (Orchard Publication)
3. MATLAB-An-Introduction-with-Application by Amos Gilat published by John Wiley & Sons.
4. http://mathworks.in/
5. MATLAB library help