INDUSTRIAL INSTRUMENTATION LAB

KIC653

SESSION 2020-2021

DEPARTMENT OF ELECTRONICS AND INSTRUMENTATION ENGINEERING

INSTITUTE OF ENGINEERING AND TECHNOLOGY LUCKNOW UTTAR PRDAESH

INDUSTRIAL INSTRUMENTATION LAB KIC653

1. Instrumentation Amplifier: Design for specific gain and verification of CMRR.
2. Analog to digital conversion using ADC kit
3. Digital to analog conversion using DAC for 4-bit/8bit systems.
4. Study of low noise and low frequency amplifier for biomedical application.
5. Design of temperature sensor circuit using RTD.
6. Design of temperature sensor circuit using thermocouple.
7. Design of Linearization and temperature measurement circuit using thermistor.
8. Study of pressure transmitter.
9. Study of Dead weight tester.
10. Study of level measurement using capacitance probe, differential pressure transmitter.
11. Study of flow measurement methods using orifice, electromagnetic and positive displacement flow meters.
12. Study of PID controller.

Experiment beyond the syllabus-

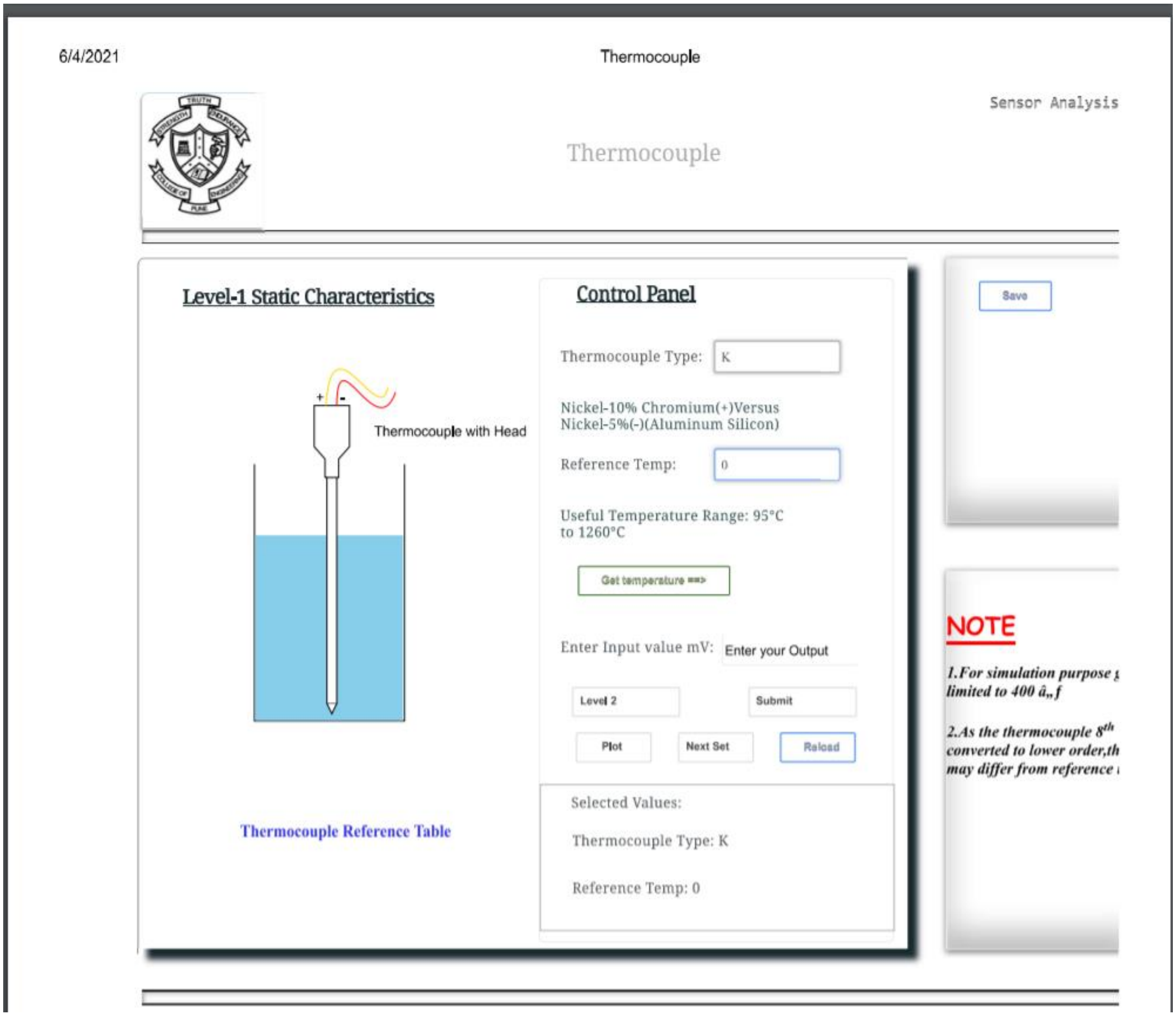
1. Characteristics of capacitive transducer (i) Variable area (ii) Variable distance.
2. Measurement of resistance using wheatstone's bridge
3. Measurement of resistance using kelvin's double bridge.
4. Measurement of capacitance using schering's bridge

Experiments performed via virtual instruments platform

Experiment-6

Objective – Temperature measurement using thermocouple.

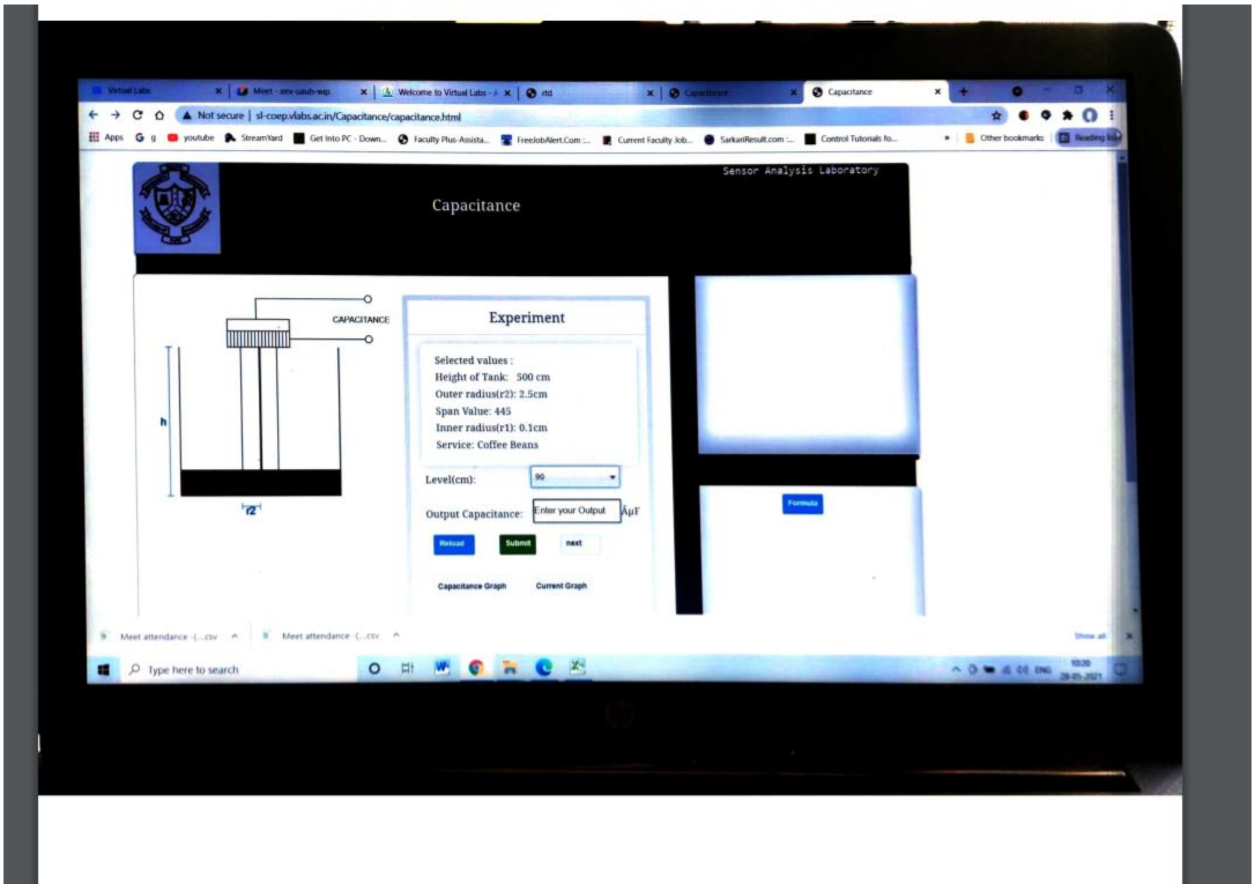
Screen shots of this experiment is given below-



Experimnet-10

Objective- Level measurement using capacitive sensor

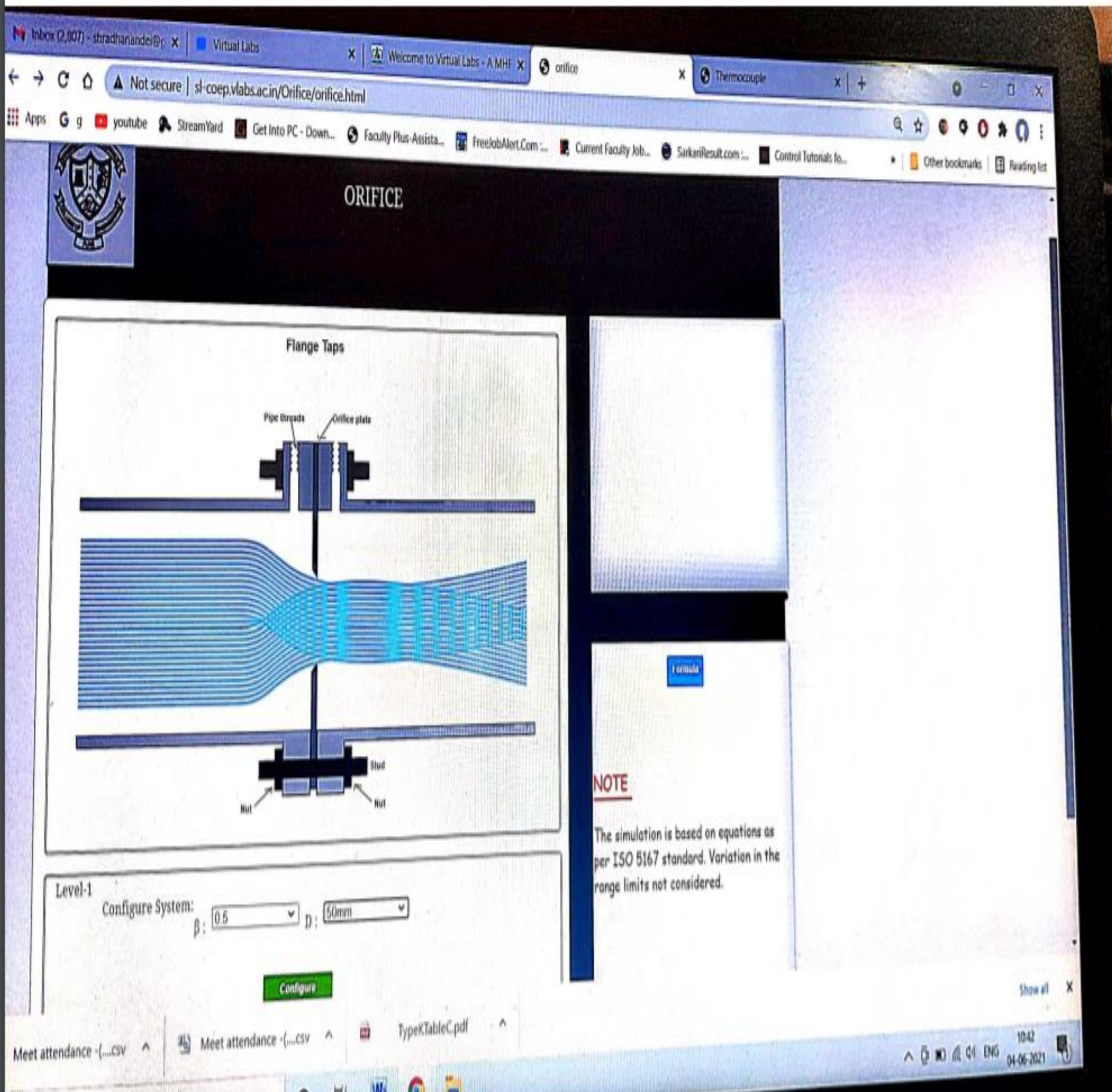
A screen shot of this experiment is given below-

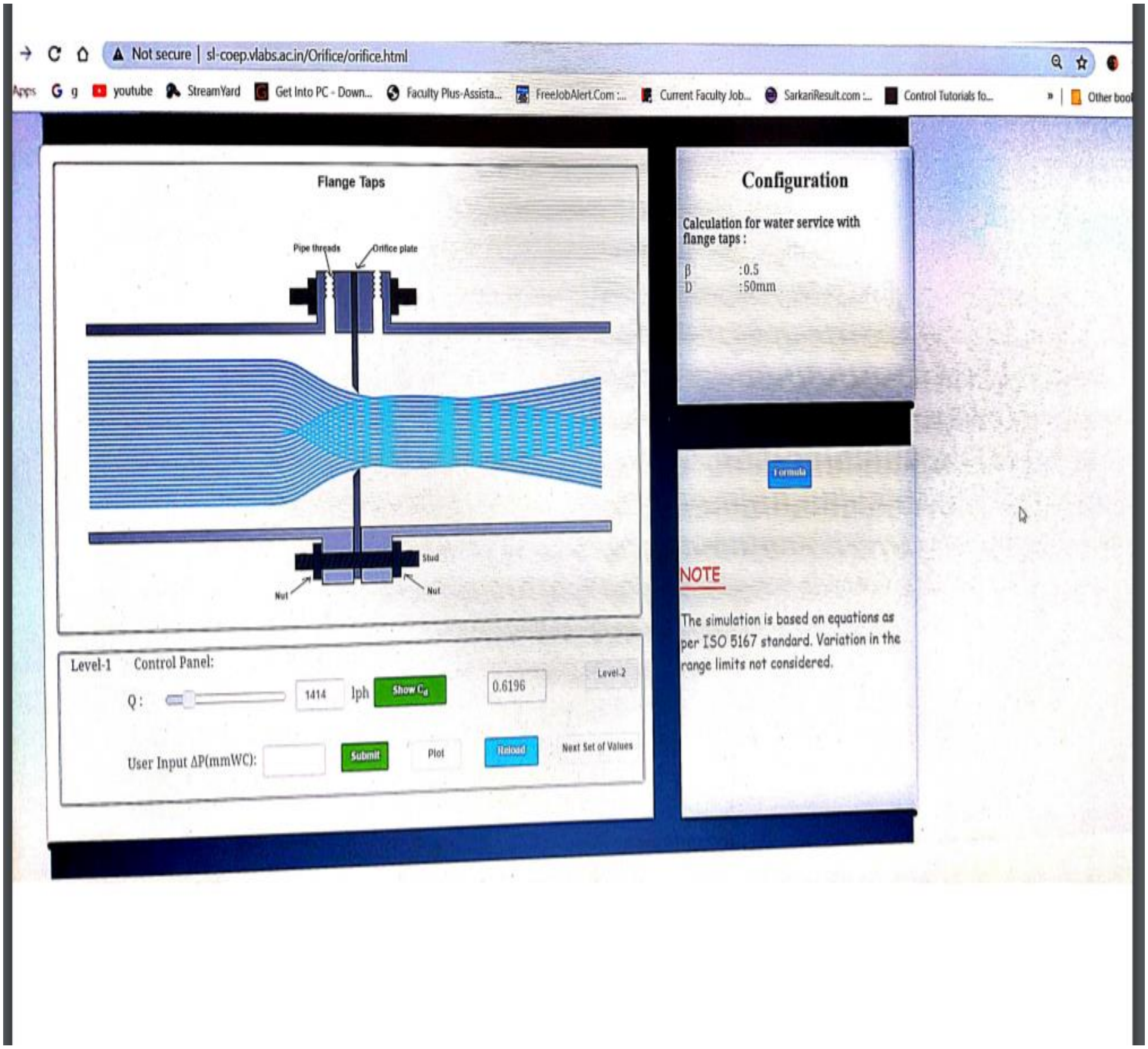


Experiment-11

Objective-Flow measurement using orifice flow meter

Screen shots of this experiment is given below-


Not secure | sl-coep.vlabs.ac.in/Orifice/orifice.html
ORIFICE
Flange Taps
Pipe threads
Orifice plate
Stud
Nut
Nut
NOTE
The simulation is based on equations as per ISO 5167 standard. Variation in the range limits not considered.
Level-1
Configure System:
β : 0.5
D : 50mm
Configure


Not secure | sl-coep.vlabs.ac.in/Orifice/orifice.html
Flange Taps
Pipe threads
Orifice plate
Stud
Nut
Nut
Configuration
Calculation for water service with flange taps :
β :0.5
D :50mm
Formula
NOTE
The simulation is based on equations as per ISO 5167 standard. Variation in the range limits not considered.
Level-1 Control Panel:
Q: 1414 lph
Show Cd
0.6196
Level-2
User Input ΔP(mmWC):
Submit
Plot
Reload
Next Set of Values

Flow measurement using orifice meter

$Q = 1414$ lph → Convert it into $\frac{m^3}{s}$

$C_d = 0.6196$

$\frac{d}{D} = 0.5$

$\beta = 0.5 = \frac{d}{D}$

$D = 50mm$

$d = 0.5D$

$d = \frac{D}{2} = 25mm$

$$Q = \frac{C_d A_2}{\sqrt{1-\beta^4}} \sqrt{\frac{2\Delta P}{\rho}}$$

From above equation we can calculate ΔP in Pascal.

Experiment-12

Objective: Design of PID controller

Theory-

r =set point (the desired value of a controlled variable is referred to as its set point)

y=process output (controlled variables)

e=error signal

u=controller output

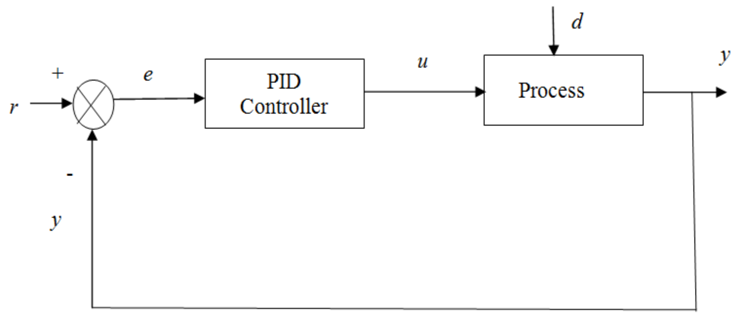
Output of the controller can be expressed as:

$$u^c(k) = K_p \left[e(k) + \frac{\Delta t}{T_i} \sum_{i=0}^{k} e(i) + \frac{T_d}{\Delta t} \Delta e(k) \right]$$

Or

$$u^c(k) = K_p e(k) + K_i \sum_{i=0}^{k} e(i) + K_d \, \Delta e(k).$$

Where K_p is the proportional gain, $K_i = K_p \left(\frac{\Delta t}{T_i}\right)$ is the integral gain, $K_d = K_p \left(\frac{T_d}{\Delta t}\right)$ is the derivative gain , T_i is the integral time, T_d is the derivative time, and Δt is the sampling time period. Proper selection of the three tuning parameters – K_p, T_i, and T_d is a critical task to attain the desired close-loop performance.



MATLAB CODES

We have written the code for following process model.

- $G_p(s) = \frac{e^{-Ls}}{(1+s)^2}$, L=0.2 second

SN.	PROCESS MODEL	DELAY	ULTIMATE GAIN	ULTIMATE PERIOD
1-	$G_p(s) = \frac{e^{-Ls}}{(1+s)^2}$	L=0.2	10.5	2.0333

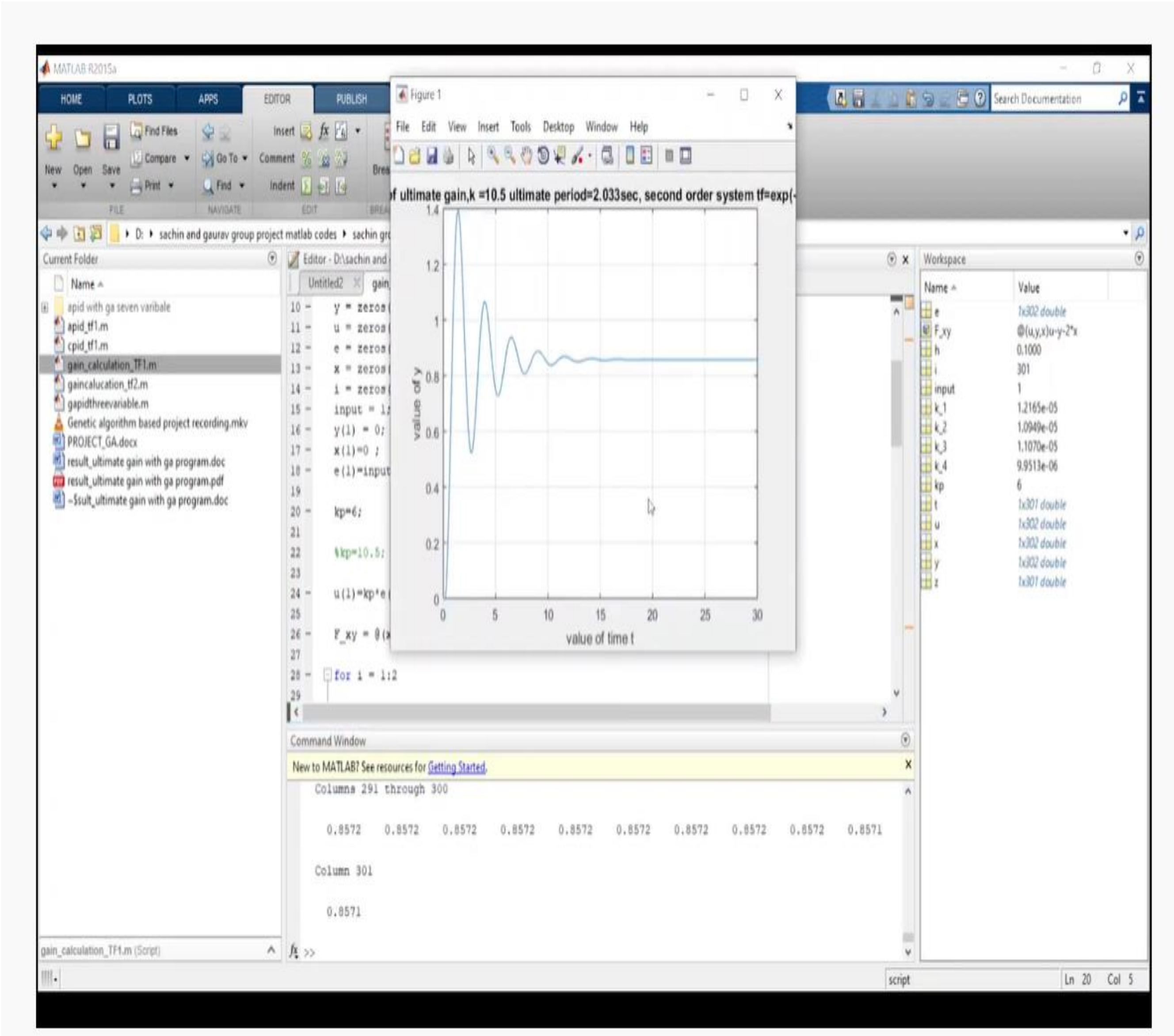
MATLAB CODE FOR PID CONTROLLER :

```
clc;
clear all;

h=0.1;
t = 0:h:16;
```

```
tf=16/h;
y = zeros(1,length(t));
u = zeros(1,length(t));
e = zeros(1,length(t));
x = zeros(1,length(t));
y(1) = 0;
x(1)=0 ;
r=1
e(1)=r - y(1);

ku=10.5;
tu=2.033;

kc=0.6*ku
ti=tu/2
td=tu/8

 u(1)=kc*(e(1) +(0.1/ti)*sum(e));

 F_xy = @(x) -2*x;

 for i = 1:2


         %y and u taken as time input and x as output


          k_1 = F_xy(x(i));
          k_2 = F_xy(x(i)+0.5*h*k_1);
          k_3 = F_xy((x(i)+0.5*h*k_2));
          k_4 = F_xy((x(i)+k_3*h));

          x(i+1) = x(i) + (1/6)*(k_1+2*k_2+2*k_3+k_4)*h;

          y(i+1)=y(i)+h*x(i+1);

          e(i+1)=r-y(i+1);

          er=sum(e);

          ed=e(i+1)-e(i);

        u(i+1)=kc*(e(i+1) +(0.1/ti)*sum(e)+(td/0.1)*ed);

end

F_xy = @(u,y,x) u-y-2*x;
```

```
for i = 3: length(t)
  k_1 = F_xy(u(i-2),y(i),x(i));

  k_2 = F_xy(u(i-2)+0.5*h,y(i)+0.5*h,x(i)+0.5*h*k_1);

  k_3 = F_xy((u(i-2)+0.5*h),(y(i)+0.5*h),(x(i)+0.5*h*k_2));

  k_4 = F_xy((u(i-2)+h ) ,(y(i)+h) ,(x(i)+k_3*h));

   x(i+1) = x(i) + (1/6)*(k_1+2*k_2+2*k_3+k_4)*h;

    y(i+1)=y(i)+h*x(i+1);
    e(i+1)=r-y(i+1);
    er=sum(e);
    ed=e(i+1)-e(i);

   u(i+1)=kc*(e(i+1) +(0.1/ti)*sum(e)+(td/0.1)*ed);

end


z=y(1:tf+1);
plot(t,z,'--')
xlabel('Time t ')
ylabel('Response y')
title(' CPID(- - -) Response of second order system TF=exp(-0.2s)/s2+2s+1)')
grid on
```

Screen shots:


MATLAB R2015a
HOME
PLOTS
APPS
EDITOR
PUBLISH
Figure 1
File Edit View Insert Tools Desktop Window Help
f ultimate gain,k =10.5 ultimate period=2.033sec, second order system tf=exp(-
value of y
value of time t
Current Folder
apid with ga seven varibale
apid_tf1.m
cpid_tf1.m
gain_calculation_TF1.m
gaincalucation_tf2.m
gapidthreevariable.m
Genetic algorithm based project recording.mkv
PROJECT_GA.docx
result_ultimate gain with ga program.doc
result_ultimate gain with ga program.pdf
~$sult_ultimate gain with ga program.doc
Workspace
Name
Value
Command Window
New to MATLAB? See resources for Getting Started.
Columns 291 through 300
0.8572 0.8572 0.8572 0.8572 0.8572 0.8572 0.8572 0.8572 0.8572 0.8571
Column 301
0.8571

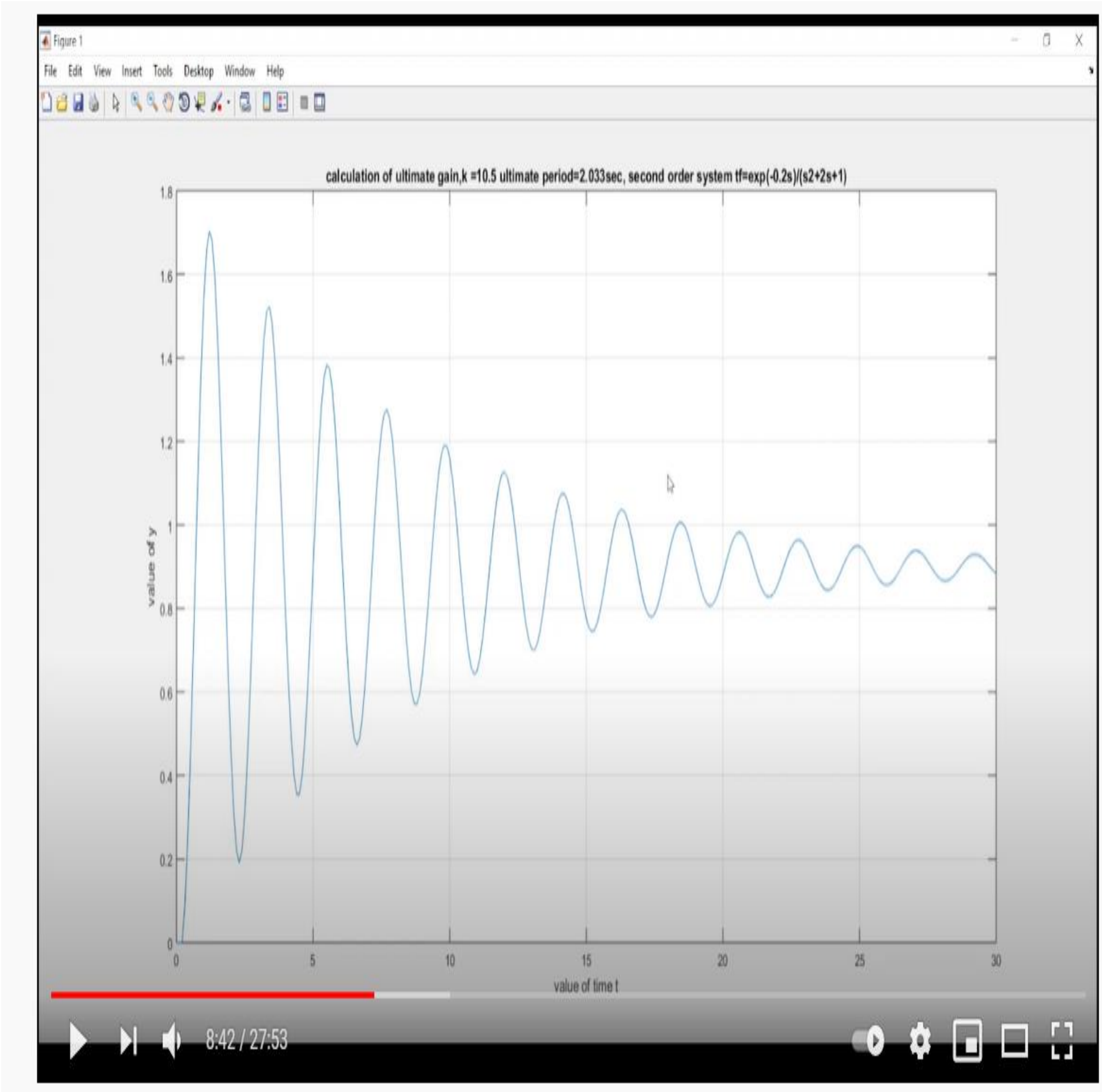


Figure 1
File Edit View Insert Tools Desktop Window Help
calculation of ultimate gain,k =10.5 ultimate period=2.033sec, second order system tf=exp(-0.2s)/(s2+2s+1)
value of y
value of time t
8:42 / 27:53

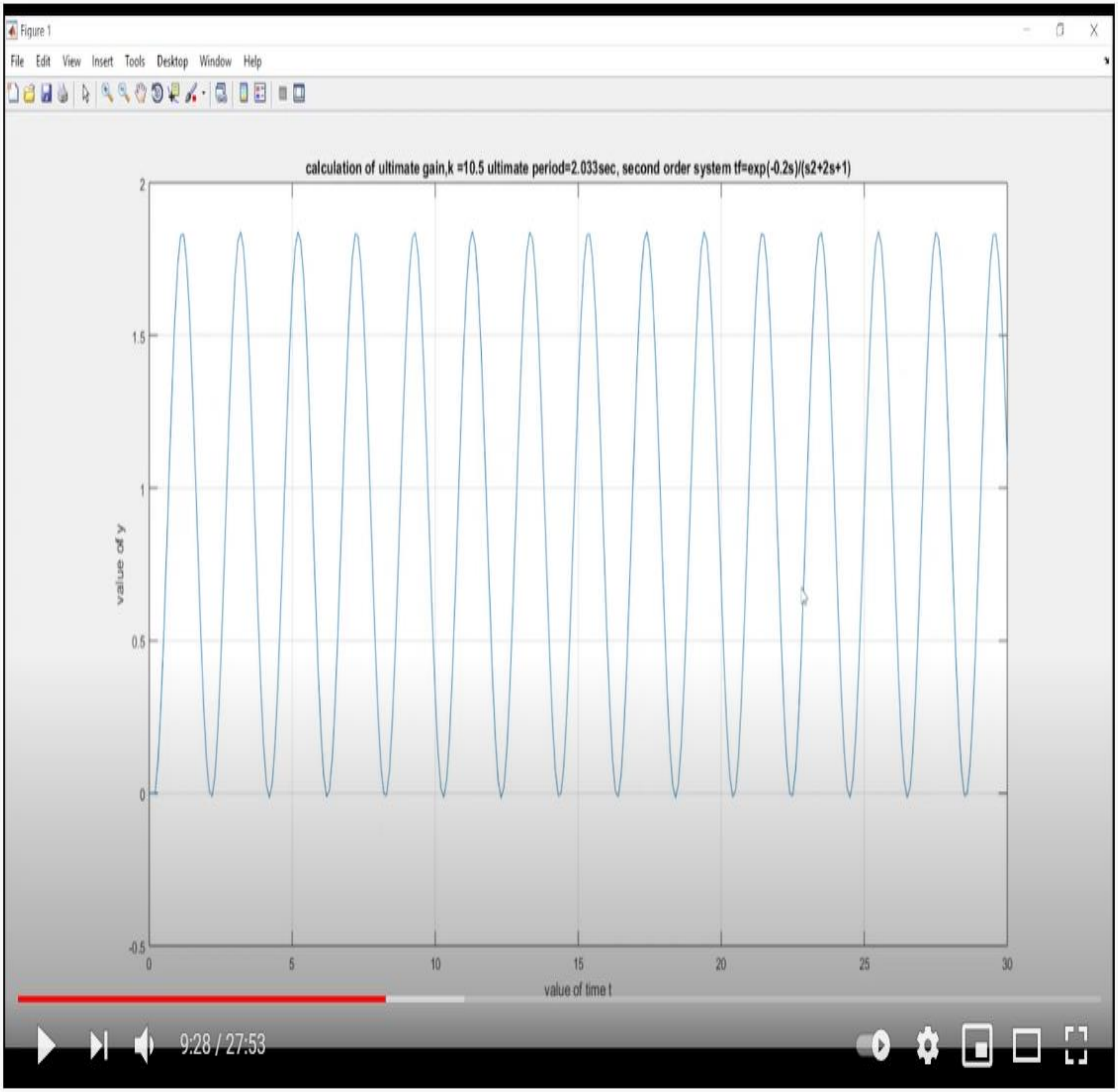


Figure 1
File Edit View Insert Tools Desktop Window Help
calculation of ultimate gain,k =10.5 ultimate period=2.033sec, second order system tf=exp(-0.2s)/(s2+2s+1)
value of y
value of time t
9:28 / 27:53

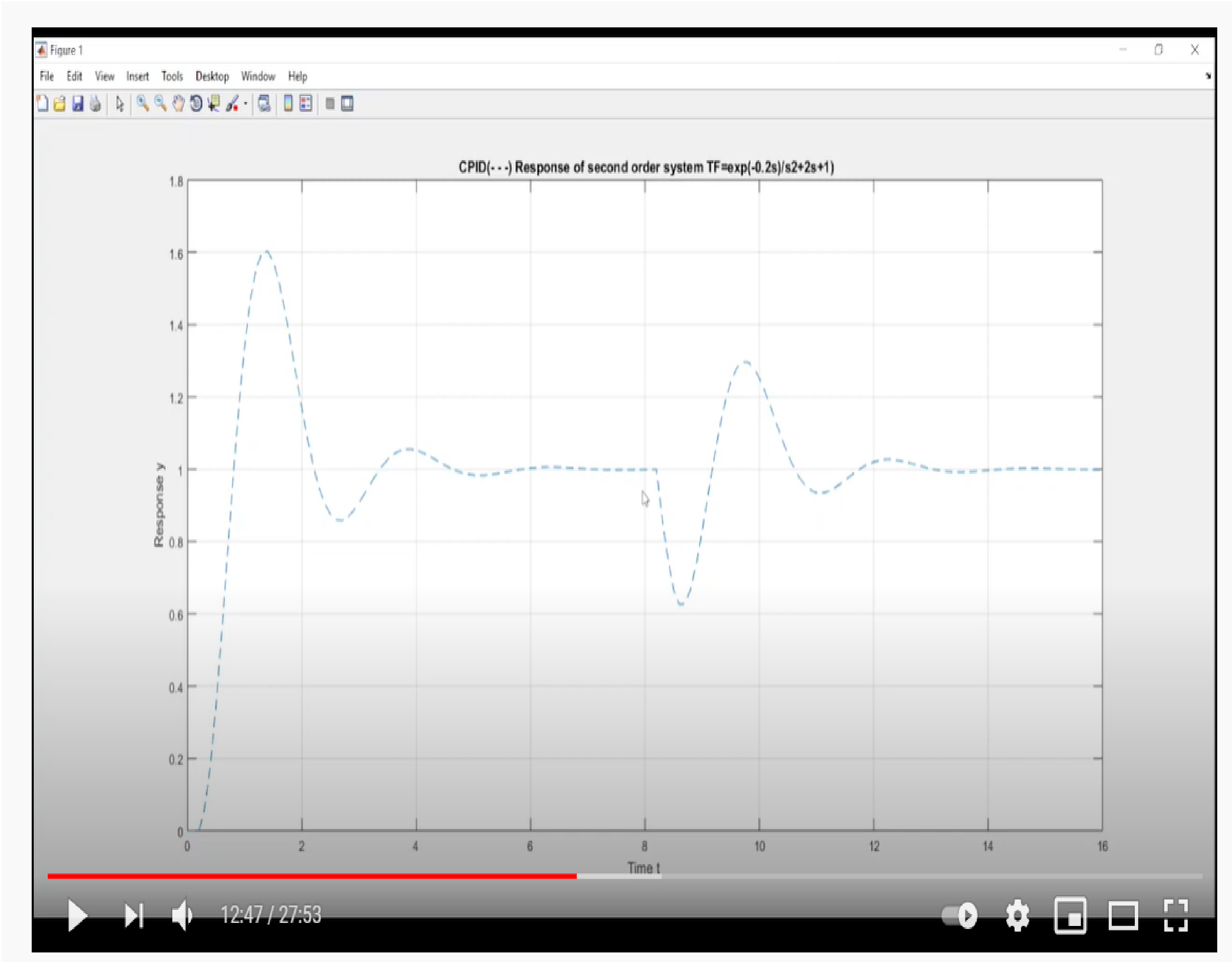


Figure 1
File Edit View Insert Tools Desktop Window Help
CPID(- - -) Response of second order system TF=exp(-0.2s)/s2+2s+1)
Response y
Time t
12:47 / 27:53

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