EE407 Process Control
Experiment 2

1. *Figure 1*

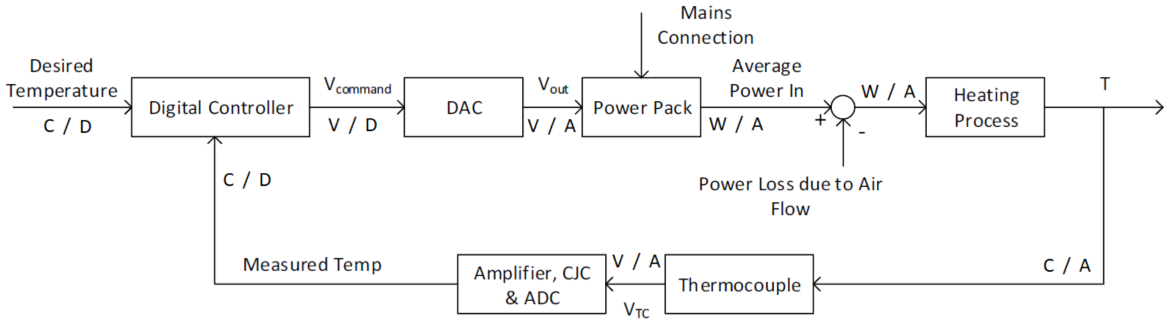

Figure 1: Block Diagram of the System

2.
   - Process Variable : Temperature
   - Measurement Sensor : Thermocouple
   - Measured Process Variable (PV) : Current Temperature Value of the Environment
   - Set Point (SP) : Desired Temperature
   - Controller Output (CO) : Command Voltage
   - Final Control Element (FCE) : TRIAC
   - Manipulated Variable (PV) : State of Heater
   - Disturbances (D) : Airflow of Fan

3. *Figure 2*

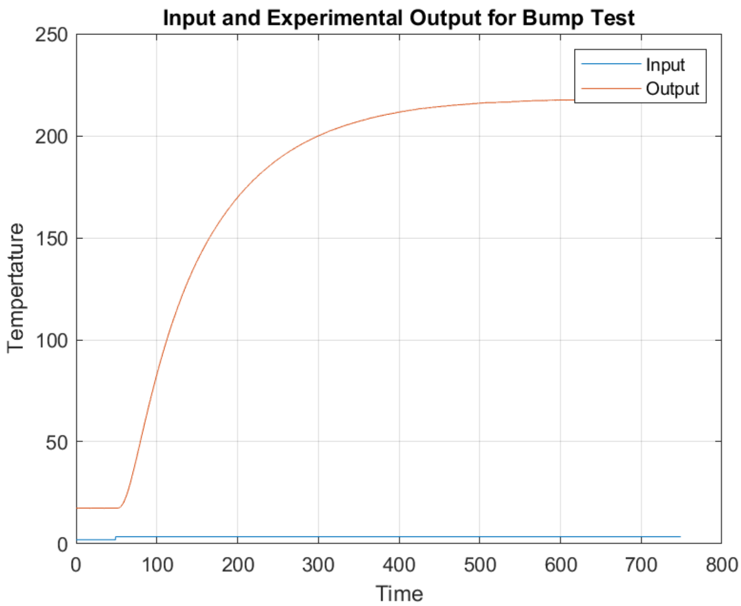

Figure 2: Input and Experimental Output for Bump Test

$$K_p = 133.5333$$

$$\tau_p = 94.2857 \; secs$$

$$\theta_p = 10.5857$$

```
%% - from exp data

Kp=63.553
Tp1=130.03
Td=3
s = tf('s')
G = (Kp/(1+Tp1*s))*exp(-Td*s)

step(G)
grid on

%% -

Yi =17.5
Yf=217.8
```

```
DY=Yf-Yi
Y1_3=Yi+DY/3
Y2_3=Yi+2*DY/3
u_in=2
u_fin=3.5
Du=u_fin-u_in
K_p=DY/Du

t_in=52.7
t1_3=101
t2_3=167
tau_p=(t2_3-t1_3)/0.7

theta_p=t1_3-0.4*tau_p-t_in
```

4. -

```
Process model with transfer function:
             Kp
  G(s) = ---------- * exp(-Td*s)
          1+Tp1*s

        Kp = 133.81
       Tp1 = 99.436
        Td = 10

Name: P1D
Parameterization:
    'P1D'
   Number of free coefficients: 3
   Use "getpvec", "getcov" for parameters and their uncertainties.
```

Figure 3: Estimated FOPDT Model Parameters

5. -

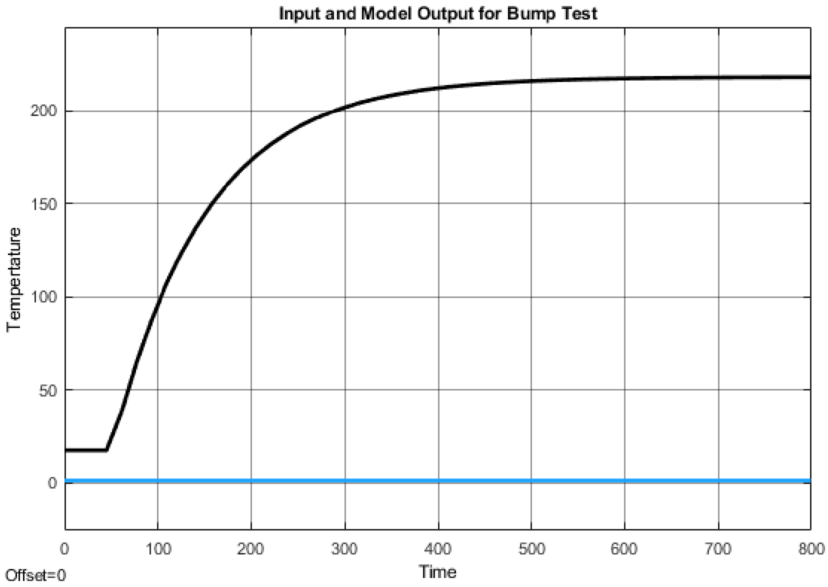

Figure 4: The Response of the Modelled System

6. -

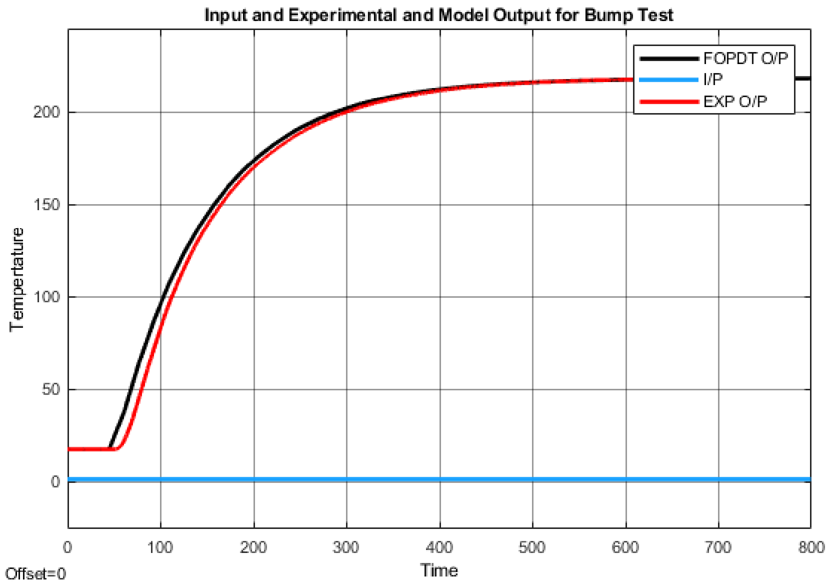

Figure 5: The Response of the Modelled System and Experimental Response

7. -

```
Kc_p_exp =(0.2/K_p)*(tau_p/theta_p)^1.22

Kc_pi_exp = (0.586/K_p)*(tau_p/theta_p)^0.916

tau_pi_exp = tau_p/(1.03-0.165*(theta_p/tau_p))

%%

K_p_m = P1D.Kp
tau_p_m= P1D.Tp1
theta_p_m = P1D.Td/10



Kc_p_model =(0.2/K_p_m)*(tau_p_m/theta_p_m)^1.22
Kc_pi_model = (0.586/K_p_m)*(tau_p_m/theta_p_m)^0.916
tau_pi_model = tau_p_m/(1.03-0.165*(theta_p_m/tau_p_m))
```

```
Kc_p_exp =

    0.0216


Kc_pi_exp =

    0.0325


tau_pi_exp =

   93.2161
```

```
Kc_p_model =

    0.4088


Kc_pi_model =

    0.2959


tau_pi_model =

   96.6952
```

8.

9.

10.

Appendices

A General Source Code for Matlab Part

```
clear
clc
load('Exp2_SysIDData.mat')
plot(time,input)
grid on;
hold on
plot(time,output)
title('Input and Experimental Output for Bump Test');
ylabel('Tempertature');
xlabel('Time');
legend('Input','Output');
savefig('images/exp2.fig');
fig=openfig('images/exp2.fig');
saveas(fig,'images/exp2.png');
close(fig);
hold off;

%% - for systemIdent.

inputa(:)=input(:)-2

plot(time,inputa)

outputa(:)=output(:) -17.5

plot(time,outputa)


%% - from exp data

Kp=63.553
Tp1=130.03
Td=3
s = tf('s')
G = (Kp/(1+Tp1*s))*exp(-Td*s)

step(G)
```

```
grid on

%% -

Yi =17.5
Yf=217.8
DY=Yf-Yi
Y1_3=Yi+DY/3
Y2_3=Yi+2*DY/3
u_in=2
u_fin=3.5
Du=u_fin-u_in
K_p=DY/Du

t_in=52.7
t1_3=101
t2_3=167
tau_p=(t2_3-t1_3)/0.7

theta_p=t1_3 -0.4*tau_p-t_in

%% -

Kc_p_exp =(0.2/K_p)*(tau_p/theta_p)^1.22

Kc_pi_exp = (0.586/K_p)*(tau_p/theta_p)^0.916

tau_pi_exp = tau_p/(1.03-0.165*(theta_p/tau_p))

%%

K_p_m = P1D.Kp
tau_p_m= P1D.Tp1
theta_p_m = P1D.Td/10



Kc_p_model =(0.2/K_p_m)*(tau_p_m/theta_p_m)^1.22
Kc_pi_model = (0.586/K_p_m)*(tau_p_m/theta_p_m)^0.916
tau_pi_model = tau_p_m/(1.03-0.165*(theta_p_m/tau_p_m))
```