

## EE407 Process Control

### Experiment 2

1. *Figure 1*

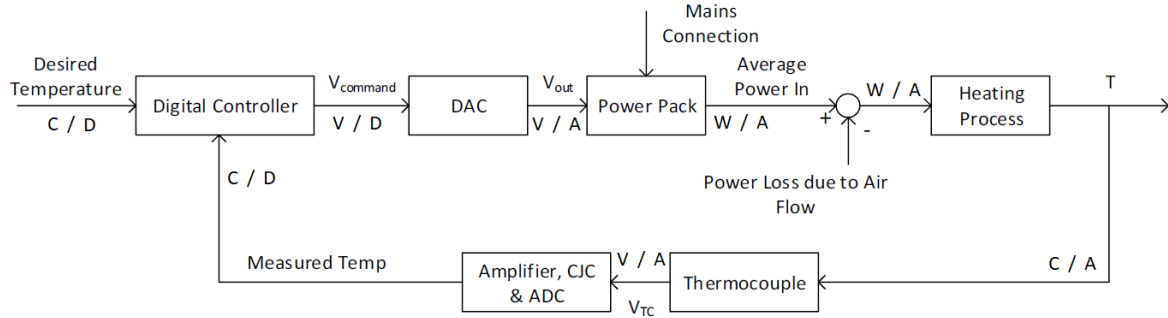


Figure 1: Block Diagram of the System

- 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*



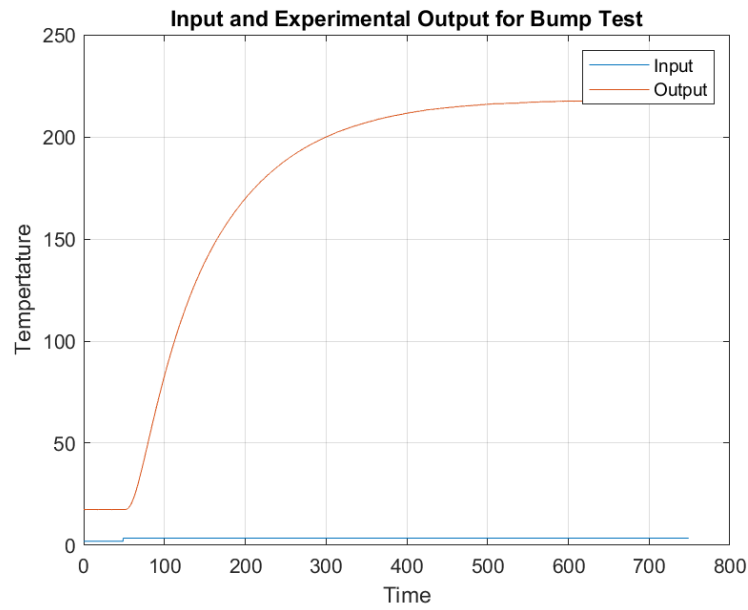


Figure 2: Input and Experimental Output for Bump Test

$$K_p = 133.5333$$

$$\tau_p = 94.2857 \text{ secs}$$

$$\theta_p = 10.5857$$

```

1 %% - from exp data
2
3 Kp=63.553
4 Tp1=130.03
5 Td=3
6 s = tf('s')
7 G = (Kp/(1+Tp1*s))*exp(-Td*s)
8
9 step(G)
10 grid on
11
12 %% -
13
14 Yi =17.5
15 Yf=217.8

```



```

16 DY=Yf-Yi
17 Y1_3=Yi+DY/3
18 Y2_3=Yi+2*DY/3
19 u_in=2
20 u_fin=3.5
21 Du=u_fin-u_in
22 K_p=DY/Du
23
24 t_in=52.7
25 t1_3=101
26 t2_3=167
27 tau_p=(t2_3-t1_3)/0.7
28
29 theta_p=t1_3-0.4*tau_p-t_in

```

4. -

```

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

      Kp = 133.81
      Tpl = 99.436
      Td = 10

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

```

Figure 3: Estimated FOPDT Model Parameters

5. -



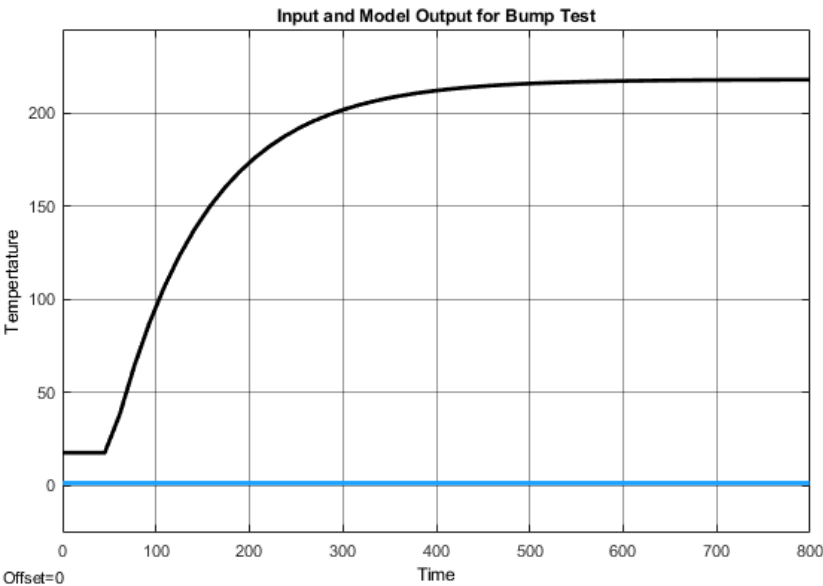


Figure 4: The Response of the Modelled System

6. -

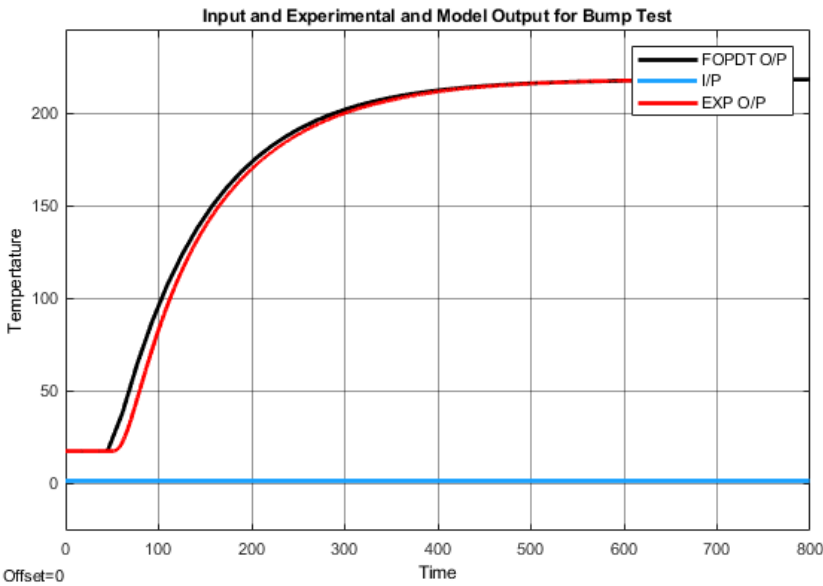


Figure 5: The Response of the Modelled System and Experimental Response



7. -

```
1 Kc_p_exp =(0.2/K_p)*(tau_p/theta_p)^1.22
2
3 Kc_pi_exp =(0.586/K_p)*(tau_p/theta_p)^0.916
4
5 tau_pi_exp = tau_p/(1.03-0.165*(theta_p/tau_p))
6
7 %%
8
9 K_p_m = P1D.Kp
10 tau_p_m= P1D.Tp1
11 theta_p_m = P1D.Td/10
12
13
14
15 Kc_p_model =(0.2/K_p_m)*(tau_p_m/theta_p_m)^1.22
16 Kc_pi_model =(0.586/K_p_m)*(tau_p_m/theta_p_m)^0.916
17 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

```

1 clear
2 clc
3 load('Exp2_SysIDData.mat')
4 plot(time,input)
5 grid on;
6 hold on
7 plot(time,output)
8 title('Input and Experimental Output for Bump Test');
9 ylabel('Tempertature');
10 xlabel('Time');
11 legend('Input','Output');
12 savefig('images/exp2.fig');
13 fig=openfig('images/exp2.fig');
14 saveas(fig,'images/exp2.png');
15 close(fig);
16 hold off;
17
18 %% - for systemIdent.
19
20 inputa(:)=input(:)-2
21
22 plot(time,inputa)
23
24 outputa(:)=output(:)-17.5
25
26 plot(time,outputa)
27
28
29 %% - from exp data
30
31 Kp=63.553
32 Tp1=130.03
33 Td=3
34 s = tf('s')
35 G = (Kp/(1+Tp1*s))*exp(-Td*s)
36
37 step(G)

```



```

38 grid on
39
40 %% -
41
42 Yi =17.5
43 Yf=217.8
44 DY=Yf-Yi
45 Y1_3=Yi+DY/3
46 Y2_3=Yi+2*DY/3
47 u_in=2
48 u_fin=3.5
49 Du=u_fin-u_in
50 K_p=DY/Du
51
52 t_in=52.7
53 t1_3=101
54 t2_3=167
55 tau_p=(t2_3-t1_3)/0.7
56
57 theta_p=t1_3-0.4*tau_p-t_in
58
59 %% -
60
61 Kc_p_exp =(0.2/K_p)*(tau_p/theta_p)^1.22
62
63 Kc_pi_exp = (0.586/K_p)*(tau_p/theta_p)^0.916
64
65 tau_pi_exp = tau_p/(1.03-0.165*(theta_p/tau_p))
66
67 %%
68
69 K_p_m = P1D.Kp
70 tau_p_m= P1D.Tp1
71 theta_p_m = P1D.Td/10
72
73
74
75 Kc_p_model =(0.2/K_p_m)*(tau_p_m/theta_p_m)^1.22
76 Kc_pi_model = (0.586/K_p_m)*(tau_p_m/theta_p_m)^0.916
77 tau_pi_model = tau_p_m/(1.03-0.165*(theta_p_m/tau_p_m))

```

