

## ANSWER KEY – LABORATORY EXERCISE 24 FAMILIARITY WITH MODEL PREDICTIVE CONTROL

### 4. MPC OPERATION

- Does the actual behavior follow the predicted behavior? Yes
- Does the predicted behavior approach the SP? Yes
- Does the PV (actual) behavior remain approximately on SP? Yes
- Does the MV (output) change to compensate for this load change? Yes
- .... which should be approximately compensated for by feedforward action. Is it? Yes
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### 5. DETAILED ANALYSIS

### 6. ANOTHER CALCULATION CYCLE, FOLLOWING A LOAD CHANGE

The following pages give an example of the worksheets which are requested by the exercise. Your data will probably be different, because no two persons will start collecting data for the worksheet with the process in the same state. Nevertheless, the example should be helpful.

Note that your predicted profile (for example, column 4) should agree with the computer-generated data (for example, column 5) except for possible round-off error in the second place to the right of the decimal.

### 7. OTHER EXPLORATION (Optional)

#### 7.2 Multiple-Input, Multiple-Output

- One at a time, change the set points for PV-1 and PV-2. Do both outputs change? Yes
- Does the other PV stay approximately on SP? Yes
- You should be seeing a random load change of both disturbance variables. Do both PV's stay approximately on SP? Yes

#### 7.3 Insufficient Degrees of Freedom

- With a higher priority given to PV-1, it will control closer to its set point, but at the expense of more deviation at PV-2. Is this what you observe? Yes

- ... priority for PV-2 of 0.95. Do the PVs move in a way that you would expect?
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Yes. PV-2 is closer to SP. There is more deviation of PV-1.

#### 7.4 Output Limiting.

- What is the largest move (change) that the controller output makes in any one calculation cycle?

6.7%. First step only
- The controller output should now show the effects of limiting the size of the move. Do you observe that?

Yes. First 3 steps are 3%

PV-1 RESPONSE  
TO UNIT STEP CHANGE OF:

Worksheet No. 1

STEP	OUT-1	LOAD-1
0	0.000	0.000
1	0.002	0.000
2	0.134	0.000
3	0.416	0.014
4	0.794	0.045
5	1.228	0.087

MODEL PREDICTIVE CONTROL WORKSHEET

using  
MPC-ControlLAB  
from  
Wade Associates, Inc.  
Houston, TX

Step No	1	2	3	4	5	6	7	8	9	10	11	12	Step No
	End of Last Cycle	Start of New Cycle	Fdbk Corr -0.210	Feedback Correction		Load Change 0.000	Feedforward Correction		Control Move -1.432	Control Correction		End of Cycle	
0	275.000	276.453	276.243	276.243	276.243	0.000	276.243	276.243	0.000	276.243	276.243	276.243	0
1	276.453	279.823	Read Actual PV from VIEW   DATA MONITOR	279.613	279.613	0.000	279.613	279.613	-0.024	279.611	279.610	279.610	1
2	279.823	284.557		284.347	284.347	0.000	284.347	284.347	-0.158	284.189	284.188	284.188	2
3	284.557	290.105		289.895	289.896	0.000	289.896	289.896	-0.491	289.405	289.404	289.404	3
4	290.105	296.070		295.860	295.860	0.000	295.860	295.860	-0.938	294.922	294.921	294.921	4
5	296.070	302.165		301.955	301.955	0.000	301.955	301.955	-1.450	300.505	300.504	300.504	5

PV-1 RESPONSE  
TO UNIT STEP CHANGE OF:

Worksheet No. 2

STEP	OUT-1	LOAD-1
0	0.000	0.000
1	0.002	0.000
2	0.134	0.000
3	0.416	0.014
4	0.794	0.045
5	1.228	0.087

MODEL PREDICTIVE CONTROL WORKSHEET  
using  
MPC-ControlLAB  
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Houston, TX

Step No.	1	2	3	4	5	6	7	8	9	10	11	12	Step No.
	End of Last Cycle	Start of New Cycle	Fdbk Corr	Feedback Correction		Load Change 5.0 (%)	Feedforward Correction		Control Move	Control Correction		End of Cycle	
				Your Predicted Profile	MPC Predicted Profile	Load Change Effect	Your Predicted Profile	MPC Predicted Profile	Control Move Effect	Your Predicted Profile	MPC Predicted Profile		
0			Actual PV		279.439	0.000	279.439	279.439					0
1			Read Actual PV from VIEW   DATA MONITOR		284.017	0.000	284.017	284.017					1
2					289.233	0.000	289.233	289.233					2
3					294.751	0.070	294.821	294.823					3
4					300.333	0.225	300.558	300.559					4
5					305.815	0.435	306.250	306.250					5