Process Control: Level

Catalogue Number	3045-0002
Category	Process Control
Duration	15 Hours

Activity 1: Introduction to Level Control

- What is Process Control?
- What is a Control Mechanism?
- What is a Controller?
- Manual and Automatic Level Control Systems
- Example: Chemical Storage Tanks
- Example: Industrial Boiler
- The Need for Controlling Systems

Activity 2: ProcessMotion Simulation Software

- ProcessMotion Software
- ProcessMotion Panel
- Simulation Software
- Manipulating the ProcessMotion Panel Display
- Task: Running ProcessMotion and Opening Multiple Displays
- Review of Process Control
- Task: Running an Experiment
- Output Analysis
- Task: Analyzing the Output Graph
- Understanding the Water Pressure Readout
- Experimenting With an Ineffective Controller
- Task: Experimenting With an Ineffective Controller
- Interpreting the Output Graph
- Experimenting With a More Effective Controller
- Task: Experimenting With a More Effective Controller
- Interpreting the Output Graph
- Experimenting With Another Effective Controller

Task: Experimenting with an Effective Controller

Interpreting the Output Graph

Activity 3: Block Diagrams and Gain

Systems and Control Systems

Sample Control Systems

Block Diagrams

Open Loop Control Systems and Gain

Testing a Control System

Task: Testing a Control System

Testing Another Control System

Activity 4: The System Block Diagram and the Final Control Element Gain

Review of Gain

ProcessMotion Panel Control System

Task: Constructing the Block Diagram of the System

The Structure and Functioning of the Pump

Final Control Element Gain of the ProcessMotion System

Calculating the Final Control Element Gain

Task: Determining the Pump Gain

Task: Recording the Data

Task: Determining the Pump Gain for Different Pump Settings

Activity 5: Calculating System Gain

Review of Gain

Process Gain of the ProcessMotion System

The Combined Gain of the Pump and Tank

System Gain

Determining the System Gain

Task: Determining the System Gain

Task: Recording the Results

Task: Changing the Resistance of the Output Valve

Control Signal Conclusions

System Gain Conclusions

Activity 6: First Order Systems

- Steady State Response
- Dynamic Response
- The Time Constant
- First Order Systems
- First Order System Laplace Transforms
- Step Inputs
- First Order System Response to a Step Input
- Notes on the Time Constant
- Task: Constructing a Graph of System Response to a Step Input
- Task: Interpreting a System Response Graph

Activity 7: The Level System Time Constant

- Review of the Time Constant
- The System Order of the Level System
- Deriving K and Tau for the Level System
- Analysis of the Steady Response of the Level System
- Determining the Dynamic Response of a First Order System
- Task: Measuring the Time Constant of the Level System Experimentally
- Task: Recording the Data
- Task: Calculating the Time Constant Analytically

Activity 8: Controlling the Level System Using Open Loop Control

- Categorizing Control Systems
- Closed Loop Control
- Open Loop Control
- Controlling the Level System Using Open Loop Control
- Task: Using Open Loop Control to Control the Water
- Task: Recording the Data
- Task: Investigating the Effect of an External Load
- Task: Adjusting the Pump Setting
- Results and Conclusions

Activity 9: Introduction to On-Off Control

- Open and Closed Loop Control Systems
- Closed Loop Control Systems
- On-Off Control Algorithm
- Task: Analyzing a Control System
- Applying On-Off Control
- On-Off Control Using Dead Band
- Tolerance

Activity 10: On-Off Control - Tasks

- On-Off Control
- Step Inputs
- Task: Step Inputs
- Task: Calculating General System Information
- System Behavior
- Task: Calculating the System Output Over Time
- The Descent of the System Response
- Task: Plotting the System Descent
- Investigating the Effects of Changing the Dead Band
- Task: Investigating the Effects of Changing the Dead Band

Activity 11: Controlling the Level System Using On-Off Control

- Review of Open Loop Control of the Level System
- On-Off Control of the Level System
- Task: Controlling the Level System Using On-Off Control
- Analysis of the System Output
- Task: Analysis of the Output Graph
- Task: Completing the Experiment
- Analysis of the Experiment Results
- Task: Investigating the Effect of an External Load

Activity 12: Proportional Control

- Proportional Control Algorithm
- Saturation
- Proportional Band
- Steady State System Characteristics Under Proportional Control
- Dynamic System Characteristics Under Proportional Control

Activity 13: First Order Systems Under Proportional Control

- Review of Proportional Control
- System Response to a Step Input
- Task: Calculating Time Values
- Task: Calculating the System Output for Kc = 0.5
- Task: Calculating the System Output for Kc = 1
- Task: Calculating the System Output for Kc = 2
- Task: Calculating the System Output for Kc = 4
- Task: Calculating the System Output for Kc = 10

Activity 14: Controlling the Level System Using Proportional Control

- Review of On-Off Control of the Level System
- Proportional Control of the Level System
- Task: Controlling the Level System Using Proportional Control
- Task: Recording the Experiment Results
- Task: Controlling the Level System for a New Value of Kc
- Task: Recording the Experiment Results
- Results and Conclusions
- Task: Controlling the Level System with Proportional Control
- Task: Recording the Experiment Results
- Results and Conclusions
- Task: Measuring the Effect of Kc on the Speed of System Response
- Results and Conclusions

Activity 15: Proportional Integral Control

- First Order Systems Under Proportional Control
- Higher Order Systems Under Proportional Control
- Integral Control
- Proportional Integral Control
- Task: Constructing a Graph of the Output of a PI Controller
- How Integral Control Eliminates Offset
- Disadvantages of PI Control
- Applying Laplace Transform to PI Control

Activity 16: Controlling the Level System Using PI Control

- Review of Proportional Integral Control
- Controlling The Level System Using PI Control
- Task: Controlling the Level System With Proportional Control
- Task: Recording the Data for Ti = 100000
- Task: Controlling the Level System With Proportional Integral Control
- Experiment 1: Results and Conclusions
- Task: PI Control in the Presence of an External Load
- Task: Recording the Experiment Results
- Task: Running the Experiment With a Load
- Task: Recording the Experiment Results
- Task: Completing the Experiments
- Experiment 2: Results and Conclusions

Activity 17: PID Control

- Review of Proportional Control
- Review of Proportional Integral Control
- Derivative Control
- Advantages of Applying a Derivative Action to a PI Controller
- Proportional Integral Derivative Control
- Demonstrating PID Control
- Task: Investigating the Effect of Changing PID Parameters
- Task: The Effect of Changing the Value of Kc
- Task: The Effect of Changing the Value of Ti
- Task: The Effect of Changing the Value of Td

Activity 18: Controlling the Level System Using Proportional Integral Derivative Control

- Review of P and PI Control
- Control of Higher Order Systems
- Review of PIDControl
- Task: Controlling the ProcessMotion Level System With a PID Controller
- Task: Adjusting the Value of Td
- Results and Conclusions
- Task: Investigating the Effect of PID Control on a Higher Order System
- Task: Adjusting the Value of Kc When Using P Control
- Task: Adjusting the value of Ti When Using PI Control
- Task: Adjusting the Value of Td When Using PID Control

Activity 19: Controller Selection and Design

- Designing a Control System
- Stage 1 Selecting an Appropriate Control Algorithm
- Stage 2 Determining the Correct Parameters
- Stage 3 Fine Tuning
- Setting the Parameters for a PID Control System
- Task: Determining the Critical Gain Value
- Task: Determining the Cycle Time
- Task: Fine Tuning the PID Controller

Activity 20: Designing Controllers for the Level System

- Review of the Controller Design Process
- Control Algorithms
- Designing a Controller for the Level System 1
- Task: Experimenting With the Controller
- Task: Examining the Controller Performance
- Task: Evaluating the Controller Performance
- Designing a Controller for the Level System 2
- Task: Testing the Controller
- Task: Examining the Controller Performance
- Task: Evaluating the Controller Performance
- Experimentation Results
- Task: Testing the Controller Under the Maximum Load
- Task: Examining the Controller Performance
- Designing a Controller for the Level System 3
- Task: Testing the Controller
- Task: Examining the Controller Performance
- Experimentation Results

Post-test