Unit 16: Instrumentation and Control Systems

Unit	**D/615/1490**
Unit level	**4**
Credit value	**15**

Introduction

Instrumentation and control can also be described as measurement automation, which is a very important area of engineering and manufacturing. It is responsible for the safe control of a wide range of processes from power stations to manufacturing facilities and even the cruise control in cars.

This unit introduces students to the important principles, components and practices of instrumentation in the controlling of a process system, together with the terminology, techniques and components that are used in such a system.

Among the topics included in this unit are: instrumentation systems, instrumentation signal terminology, signal conversion and conditioning, process control systems, process controller terminology, system terminology and concepts, system tuning techniques and application of predicted values to a control system.

On successful completion of this unit students will be able to explain why the measurement of system parameters is critical to a successful process control performance, describe when and how such measurements are carried out, and develop skills in applying predicted values in order to ensure stability within a control system for a range of input wave forms.

Learning Outcomes

By the end of this unit students will be able to:

1. Identify the instrumentation systems and devices used in process control.
2. Investigate the industrial process control systems.
3. Analyse the control concepts and technologies used within an industrial process.
4. Apply predicted values to ensure stability within a control system.

Essential Content

LO1 **Identify the instrumentation systems and devices used in process control**

Instrumentation systems:

Sensors and transducers used in instrumentation including resistive, inductive, capacitive, ultrasonic, pressure, semiconductor, thermocouple and optical

Instrumentation signal terminology:

The importance of instrumentation signal terminology, including accuracy, error, drift, repeatability, reliability, linearity, sensitivity, resolution, range and hysteresis

Signal conversion and conditioning:

Conversion and conditioning of signals, including analogue, digital, optical, microprocessor, wireless and industry standard signal ranges

LO2 **Investigate process control systems and controllers**

Process control systems:

The need for process control systems, including quality, safety, consistency, optimisation, efficiency, cost and environmental considerations

Process controller terminology:

Defining deviation, range, set point, process variables, gain, on-off control, two step control and three term control PID (proportional, integral and derivative)

LO3 **Analyse the control concepts used within a process**

System terminology and concepts:

Recognise system terminology and concepts, including distance velocity lags, capacity, resistance, static and dynamic gain, stability, feedback types, open and closed loop, feed forward control and control algorithms

System tuning techniques:

Investigate system tuning techniques, including Zeigler-Nichols, continuous cycling, reaction curves, decay methods and overshoot tuning

LO4 **Apply predicted values to ensure stability within a control system**

Predicted values:

Apply predicted values to a control system using simulation to investigate system response accuracy, responses to a range of input signal types, stability of the system and possible improvements

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Identify the instrumentation systems and devices used in process control		**D1** Critically review the industrial application of an instrumentation and control process system, using research evidence
P1 Define the types of sensor and transducers used in process control **P2** Describe how the sensors and transducers function **P3** Define the signal terminology used in process control **P4** Explain the different methods and standards used in signal conversion and conditioning	**M1** Explore industrial applications for sensors and transducers **M2** Analyse the accuracy of the sensors and transducers used in a particular application	
LO2 Investigate process control systems and controllers		**D2** Develop a recommendation for improvement to process control systems and controllers
P5 Describe the importance of process control systems **P6** Define the process controller terminology used in industrial applications	**M3** Explain a typical industrial application for a process control system	

Pass	Merit	Distinction
LO3 Analyse the control concepts used within a process		**D3** Analyse the effectiveness of the control concepts used within a given process and suggest improvements
P7 Define the control terminology and concepts used in process control systems **P8** Describe the system tuning methods and techniques employed to improve performance	**M4** Explain the control terminology, concepts and tuning techniques used in a typical industrial application	
LO4 Apply predicted values to ensure stability within a control system		**D4** Discuss why the system responds in a certain way as the signals are applied
P9 Demonstrate the correct use of an instrumentation and control virtual simulation	**M5** Show how the virtual control system responds to a range of signal inputs	

Recommended Resources

Textbooks

BOLTON, W. (2015) *Instrumentation and Control Systems*. 2nd Ed. Newnes.

ESSICK, J. (2012) *Hands-On Introduction to LabVIEW for Scientists and Engineers*. 2nd Ed. Oxford University Press.

NISE, N.S. (2011) *Control Systems Engineering*. 6th Ed. John Wiley & Sons.

Journals

Journal of Process Control.

Links

This unit links to the following related units:

Unit 40: Commercial Programming Software

Unit 54: Further Control Systems Engineering