Unit 41: Distributed Control Systems

Unit code	**M/615/1509**
Unit level	**5**
Credit value	**15**

Introduction

With increased complexity and greater emphasis on cost control and environmental issues, the efficient control of manufacture and processing plant becomes ever more important. While small and medium scale industries require Programmable Logic Controller (PLC) and Supervisory Control and Data Acquisition (SCADA) technologies, large scale applications require Distributed Control Systems (DCS).

This unit introduces students to the applications of Distributed Control Systems in industrial measurements and control engineering, the different types of industrial networking used in control and instrumentation, the analysis of the performance of a given control system, and how to suggest appropriate solutions using a variety of possible methods.

On successful completion of this unit students will be able to explain the impact of automated systems in modern control processes, explain the basic concepts, architecture, operation and communication of distributed control systems, identify appropriate techniques to specify and implement a simple DCS and develop programmes to use machine interfaces to monitor and control the behaviour of a complex system.

Learning Outcomes

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

1. Explore the impact of automated systems in modern control processes.
2. Evaluate the basic concepts, architecture, operation and communication of Distributed Control Systems.
3. Suggest appropriate techniques to specify and implement a simple Distributed Control System.
4. Develop programmes to use machine interfaces to monitor and control the behaviour of a complex system.

Essential Content

LO1 **Explore the impact of automated systems in modern control processes**

Modern control processes:

Introduction to computer-based control systems and typical distributed control systems

An overview of DCS and SCADA systems

Fundamentals of PLC

Comparison of DCS, SCADA and PLCs

Selection and justification of control strategies

LO2 **Evaluate the basic concepts, architecture, operation and communication of Distributed Control Systems**

Distributed Control Systems:

Evolution and description of commercial DCS, DCS elements

Basic DCS controller configuration

Introduction to basic communication principles and protocol for DCS, PLC and SCADA

Hierarchical systems and distributed systems

Introduction to simulation models and packages

LO3 **Suggest appropriate techniques to specify and implement a simple Distributed Control System**

Techniques:

Introduction to programmable controllers, programming of PLC and DCS systems

Operator interface

Alarm system management for DCS systems

Distributed Control System reporting

Configuration of hardware and software of PLC and DCS

Programmable controller interfacing and troubleshooting

Configuration of a typical DCS control using typical plant problems

LO4 **Develop programmes to use machine interfaces to monitor and control the behaviour of a complex system**

Behaviours:

Computation of control systems

Control and supervision of Distributed Control Systems

Human Machine Interfaces (HMIs) and alarms

Network communication standards

Application of field interfaces and networks

Application of diagnostic and maintenance consideration

Project implementation phases and life cycle

Overview of future trends (e.g. digital control, intelligent systems and virtual instruments)

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Explore the impact of automated systems in modern control processes</td><td rowspan="3">D1 Critically evaluate and justify the selection of the control strategies and their function against the specifications of a DCS</td></tr>
<tr><td>P1 Discuss the application of DCS, SCADA and PLC, and their respective fields of application

P2 Investigate the component parts and their respective functions, in a modern control process

P3 Review the main building blocks (layout), communication paths and signal level(s) of a DCS</td><td>M1 Evaluate the use of DCS from field devices to commercial data processing

M2 Illustrate the control modes, structures, and diagnostic methods used in controllers</td></tr>
<tr><td colspan="2">LO2 Evaluate the basic concepts, architecture, operation and communication of Distributed Control Systems</td></tr>
<tr><td>P4 Evaluate the concept, architecture, operation and communication of DCS, SCADA and PLC in their respective applications

P5 Review the hierarchical systems in DCS

P6 Assess the use of Local Area Network, field bus types, and protocols</td><td>M3 Critique the input output interface, fieldbus protocols and physical layers of a distributed control system

M4 Critically examine the application of local area network communication and network types to distributed control systems</td><td>D2 Critically evaluate the performance of the operator interface in a DCS and its associated hardware</td></tr>
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Pass	Merit	Distinction
LO3 Suggest appropriate techniques to specify and implement a simple Distributed Control System		**D3** Analyse the interfacing, structure, and performance of a good alarm system
P7 Review the application and implementation of the DCS systems **P8** Determine appropriate techniques for the application of DCS in different environments **P9** Design and implement a simple DCS to satisfy predefined parameters	**M5** Develop a high level programme for a typical plant problem **M6** Explore the hardware and software configuration of a typical plant problem, making use of various operator display configurations	
LO4 Develop programmes to use machine interfaces to monitor and control the behaviour of a complex system		**D4** Analyse and justify the choice of hardware, software and communication systems and its strategy in terms of architecture, system requirements, system integration and toolkits available
P10 Explain the importance of the control principles and supervision of a DCS **P11** Apply HMI to different process control applications and understand the alarm reporting **P12** Demonstrate the role of the operator interface, associated hardware, diagnostics and maintenance for a DCS	**M7** Show how the configuration control procedures ensure data integrity **M8** Explore the requirements for in-built diagnostics and maintenance diagnostic routines	

Recommended Resources

Textbooks

BAILEY, D. and WRIGHT, E. (2003) *Practical SCADA for Industry*. Newnes.

BOYER, S. (2004) *SCADA-Supervisory Control and Data Acquisition System*. 3rd Ed. The Automation Systems and Automation Society (ISA) publication.

SHARMA, K. (2011) *Overview of Industrial Process Automation*. Elsevier.

Links

This unit links to the following related units:

Unit 40: Commercial Programming Software

Unit 54: Further Control Systems Engineering