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

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<thead>
<tr>
<th>Pass</th>
<th>Merit</th>
<th>Distinction</th>
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<tr>
<td><strong>LO1</strong> Explore the impact of automated systems in modern control processes</td>
<td><strong>P1</strong> Discuss the application of DCS, SCADA and PLC, and their respective fields of application</td>
<td><strong>M1</strong> Evaluate the use of DCS from field devices to commercial data processing</td>
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<td><strong>P2</strong> Investigate the component parts and their respective functions, in a modern control process</td>
<td><strong>M2</strong> Illustrate the control modes, structures, and diagnostic methods used in controllers</td>
<td><strong>D1</strong> Critically evaluate and justify the selection of the control strategies and their function against the specifications of a DCS</td>
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<td><strong>P3</strong> Review the main building blocks (layout), communication paths and signal level(s) of a DCS</td>
<td><strong>P4</strong> Evaluate the concept, architecture, operation and communication of Distributed Control Systems</td>
<td><strong>D2</strong> Critically evaluate the performance of the operator interface in a DCS and its associated hardware</td>
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<td><strong>LO2</strong> Evaluate the basic concepts, architecture, operation and communication of Distributed Control Systems</td>
<td><strong>P5</strong> Review the hierarchical systems in DCS</td>
<td><strong>M3</strong> Critique the input output interface, fieldbus protocols and physical layers of a distributed control system</td>
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<td><strong>P6</strong> Assess the use of Local Area Network, field bus types, and protocols</td>
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<td><strong>M4</strong> Critically examine the application of local area network communication and network types to distributed control systems</td>
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<td><strong>LO3</strong> Suggest appropriate techniques to specify and implement a simple Distributed Control System</td>
<td><strong>D3</strong> Analyse the interfacing, structure, and performance of a good alarm system</td>
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<td><strong>P7</strong> Review the application and implementation of the DCS systems</td>
<td><strong>M5</strong> Develop a high level programme for a typical plant problem</td>
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<td><strong>P8</strong> Determine appropriate techniques for the application of DCS in different environments</td>
<td><strong>M6</strong> Explore the hardware and software configuration of a typical plant problem, making use of various operator display configurations</td>
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<td><strong>P9</strong> Design and implement a simple DCS to satisfy predefined parameters</td>
<td><strong>P7</strong> Review the application and implementation of the DCS systems</td>
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<td><strong>P10</strong> Explain the importance of the control principles and supervision of a DCS</td>
<td><strong>M7</strong> Show how the configuration control procedures ensure data integrity</td>
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<td><strong>P11</strong> Apply HMI to different process control applications and understand the alarm reporting</td>
<td><strong>M8</strong> Explore the requirements for in-built diagnostics and maintenance diagnostic routines</td>
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<td><strong>P12</strong> Demonstrate the role of the operator interface, associated hardware, diagnostics and maintenance for a DCS</td>
<td><strong>P10</strong> Explain the importance of the control principles and supervision of a DCS</td>
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Recommended Resources

Textbooks

Links
This unit links to the following related units:
Unit 40: Commercial Programming Software
Unit 54: Further Control Systems Engineering