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Industrial Instrumentation and Modern Control Systems

2 - 13 December 2024

Paris (France)

Industrial Instrumentation and Modern Control Systems

course code: E6005 From: 2 - 13 December 2024 Venue: Paris (France) - course Fees: 6750 Euro

Introduction

In an industrial situation where it is required to measure and control some aspect of a process, it is often the application of the knowledge and the ingenuity of the Engineer or Technician which is relied upon to solve the measurement and control problem. Therefore a fundamental understanding of the principle of operation of a range of sensors/transducers and instrumentation techniques applicable in an industrial situation combined with a working knowledge of Process control techniques and tuning methods equips the Engineer or Technician with the necessary skills and makes them invaluable in their workplace

The attendees will investigate the concepts of instrumentation and measurement and will acquire the knowledge relating to the characteristics and properties of the variables being measured. Moreover, the delegate will gain an understanding of the Process control systems and methods used in a modern industrial system

This is a practical and hands-on course and where applicable, theoretical studies will be supplemented with practical activities where the delegate will have the opportunity to design, develop, build, test and evaluate their own instrumentation systems

Some of the main topics covered include:

- Introduction to Instrumentation systems and Process variables. Symbols and units used and sample calculations
- Temperature Measurement techniques
- Strain measurement
- Investigation of Pressure and Flow measurement
- Ultrasonic techniques for non-invasive process measurement
- Practical activities to design, build, calibrate and signal condition a typical sensor application

Objectives

The main objectives of this seminar are:

- To give an understanding of the principles and practice of a range of sensors and transducers
- By using a hands-on approach, enable the delegate to investigate the operation of an instrumentation system through designing, building and testing typical sensor combined with appropriate signal conditioning circuits
- To allow the delegate to become familiar and confident with a range of measurement techniques
- To understand the concepts of Process Control and acquire the knowledge relating to the characteristics and properties of a process variable being measured
- To disseminate and share experience and knowledge with other delegates through open session discussions hence broadening the knowledge base of all
- To become familiar and knowledgeable with PID control and develop the ability to ‘tune’ a

process control system using PID control
- To have the confidence and knowledge to apply the above techniques and principles to solve an unfamiliar and bespoke measurement situation in the workplace

Training Methodology

The seminar is delivered via a series of mixed activities which will at times involve delegate participation. Theoretical content is delivered by informal lecture and discussion and supplemented where appropriate with tutorial sessions using worked examples. An opportunity is given for delegates to perform their own calculations based on sample systems

An important part of the program is the hands-on aspect. Approximately a quarter of the total time will be devoted to practical activities. Delegates will acquire the skills to design their own instrumentation system from a given sensor(s) and specification and also, using relevant software, acquire the skills to ‘tune’ a process control system

Organisational Impact

By attending this seminar the delegate will return to their company more confident in the knowledge and use of sensors and instrumentation systems generally. More specifically, they will:

- Be equipped with new skills and knowledge which must impact positively within the company structure
- Be able to evaluate the suitability and application of current in-house instrumentation and control systems and offer guidance and advise on whether such systems may be modified or improved
- Consequently be able to leverage their skills to potentially cause an increase within the plant or process in term of overall productivity and efficiency through analysis of current systems
- Be better equipped to advise on new system installations in terms of sensor choice and specification, system monitoring techniques and circuit design
- Potentially through their newly acquired knowledge be able to advise on in-house design of plant process and instrumentation systems thereby negating or at least reducing the dependency on external agencies and vendors
- Therefore potentially contribute towards and result in plant and process cost reductions leading to financial savings for the company

Personal Impact

The delegate will benefit personally from attendance of this seminar and will enhance their own knowledge base and level of confidence in the area of measurement systems and Process Control Engineering. Specifically the delegate will be able to:

- Understand the major technologies used in the measurement of flow, temperature, pressure, strain and level
- Review the construction and operation of the most important sensors and transducers and their application in process measurement systems
- Evaluate and select the most appropriate sensor technology for a given instrumentation

system
- Design, build and test using a given specification and sensor, their own instrumentation system
- Identity components and features of a Process control system
- Calibrate and signal condition the above system and take measurements from the system
- Understand the limitations of Open loop systems and be aware of the inherent problems associated with Closed loop negative feedback systems
- Optimise control by tuning a system using relevant software

SEMINAR OUTLINE

Introduction to Sensors, Transducers and Instrumentation Systems

- Course schedule and layout
- Introduction to Sensors, Transducers and Instrumentation Systems
- Examples
- Terms and definitions associated with Instrumentation systems, including;
    - Maximum error
    - Hysteresis
    - Repeatability
    - Sensitivity
    - Resolution
    - Span
    - Response time
- Examples
- Process Variables
- Mass flow
- Volumetric flow rate
- Pressure
- Viscosity
- Turbidity
- Examples

Strain, Pressure and Flow Measurement (also begin practical activities)

- Principle of Strain Measurement – tension, compression, stress, strain, Youngs modulus
- Principle of operation, application and installation considerations
- Gauge types – principle of operation and configurations
- Examples
- Principles of Pressure measurement
- Devices; principle of operation, application and installation considerations of:
    - Diaphragms
    - Bellows
    - Capacitive devices
    - Fibre Optic pressure measurement techniques
- Principles of flow measurement
- Reynolds number

- Devices; principle of operation, application and installation considerations of Invasive types:
- Coriolis Flowmeter
- Differential Pressure type flowmeters
    - Orifice plate
    - Venturi tube
    - Flow nozzle
    - Dall flow tube
- Electromagnetic flowmeters
- Devices; principle of operation, application and installation considerations of Non invasive types:
- Practical activity 1 – Design and Calibrate liquid level process measurement system

Temperature, Level and Non-Invasive Ultrasonic Measurement Techniques

- Temperature scales
- Devices; principle of operation, application and installation considerations of:
    - Resistance temperature detectors (RTD’s)
    - Thermistors
    - Thermocouples
    - Radiation Pyrometers
- Examples
- Principle of single point and continuous level measurement techniques
- Direct and indirect level measurement techniques
- Devices; principle of operation, application and installation considerations of:
- Ultrasonic techniques
- Capacitive techniques
- Pressure techniques
- Principles and applications of Ultrasonic techniques for non-invasive measurement
- Doppler shift and transit techniques
- Principle of operation, application and installation considerations of Non-invasive flow measurement
- Ultrasonic flowmeters
- Practical activity 2 – Design and Calibrate liquid level process measurement system

Introduction to Process Control Engineering

- Control Strategies
- Block diagram representation
- Control components
- Servomechanisms and Regulators
- Open and closed loop systems
- Negative Feedback (NFB)
- Transfer Functions
    - 1st and 2nd order systems
- Examples – Transfer functions and Closed Loop systems
- ON/OFF control
- Two step control action
- Proportional control
- Proportional band vs. proportional gain

- Proportional offset
- Reset
- Integral action
- Integral windup
- Derivative action
- PID control
- Practical activity 3 – Design and Calibrate (thermocouple) temperature measurement system

Tuning PID Controllers

- Stability
- System response
- Bode plot
- Nyquist plot
- Load disturbances and offset
- Empirical methods of setting Controllers
    - Open loop reaction curve method (Ziegler-Nichols)
    - Default and typical settings
    - Closed loop continuous cycling method (Ziegler-Nichols)
- Fine tuning
- Practical activity 4 – tuning a Control system using the Ziegler-Nichols methods
- Practical activity 5 – Investigation of Strain measurement techniques