

DAY 1

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

DAY 2

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

- Principle of Strain Measurement – *tension, compression, stress, strain, Youngs modulus*
- Principle of Operation, Typical Uses and Installation Considerations
- Gauge Types – *Principle of Operation and Configurations*
- Examples
- Principles of Pressure Measurement
- Devices: Principle of Operation - *Typical Uses and Installation Considerations of*
 - Diaphragms
 - Bellows
 - Capacitive Devices
 - Fibre Optic Pressure Measurement Techniques
- Principles of Flow Measurement

- Reynolds Number
- Devices: Principle of Operation - *Typical Uses and Installation Considerations of Invasive Types*
 - Coriolis Flowmeter
 - Differential Pressure Type Flowmeters
 - Orifice Plate
 - Venturi Tube
 - Flow Nozzle
 - Dall Flow Tube
- Devices: Principle of Operation - *Application and Installation Considerations of Non-invasive Types*
 - Electromagnetic Flowmeters
- Practical Activity 1: Design and Build a Liquid Level Process Measurement System

DAY 3

Temperature, Level and Non-Invasive Ultrasonic Measurement Techniques

- Temperature Scales
- Devices: Principle of Operation - *Typical Uses 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 - *Typical Uses 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
- Devices: Principle of Operation - *Typical Uses and Installation Considerations of Non-invasive Flow Measurement*
- Ultrasonic Flowmeters
- Practical Activity 2: Calibrate the Liquid Level Process Measurement System

DAY 4

Introduction to Process Control Engineering

- Control Strategies
- Block Diagram Representation
- Control Components
- Servomechanisms and Regulators
- Open and Closed Loop Systems
- Transfer Functions
- Negative Feedback (NFB)
 - 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: Signal Condition the Output from the Liquid Measurement System and (if time allows) Design and Build a Strain Gauge Measurement System

DAY 5

Tuning PID Controllers

- 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