JEE326 Instrumentation and Process Control

**Week 1**

Unit Outline

Chapter 1 Introduction to Inst and PC

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**Main Topics**

- Unit Outline (updated version):
  - Unit description/Learning outcomes
  - Contents/theory and practical
  - Assessment information
- Chapter 1 An Introduction to Instrumentation and Process Control

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**An Overview**

- Sensors, transducers, transmitters and controllers in marine and offshore sectors
  - Ships: LNG, Cruise, Supply etc.
  - Oil rigs and platforms
  - Submarines and AUVs/ROVs

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**Unit Outline**

- Unit description:
  - Fundamentals of instrumentation, methods of common measurement in marine and offshore industry
  - Basic control theory: how a control system work to maintain a quantity as desired
- Learning Outcomes:
  - (p.2 Unit Outline)

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**Unit Outline**

- Fundamentals of instrumentation
  - Basic principles of transducers/sensors
  - Standard drawing symbols
  - Signal conditioning, temperature, pressure, flow, level, density, viscosity
  - Actuators and final control elements
- Basic control engineering
  - On/Off control, P, PI, PD, PID control
  - Types of controllers (pneumatic, hydraulic, elec)
- Labs: operation of PC-based M.S. & controllers

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**Unit Outline**

- Learning resources/Textbooks: Lecture Notes
- Recommended textbook:
- References:
Unit Outline

- E-learning resources
  - Lecturer’s website:
- Other resources
  - [http://www.pc.education.mcmaster.ca/Instrumentation/go_inst.htm](http://www.pc.education.mcmaster.ca/Instrumentation/go_inst.htm)

Unit Outline

- **Class time (updated timetable on 12/7/10):**

<table>
<thead>
<tr>
<th>Class</th>
<th>Day</th>
<th>Time</th>
<th>Location</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>Mon</td>
<td>3:10-5:00</td>
<td>G47</td>
<td>All</td>
</tr>
<tr>
<td>Lecture</td>
<td>Tue</td>
<td>1:10-2:00</td>
<td>G83</td>
<td>All</td>
</tr>
<tr>
<td>Tutorial</td>
<td>Tue</td>
<td>2:10-3:00</td>
<td>G83</td>
<td>All</td>
</tr>
<tr>
<td>Labs</td>
<td>Thu</td>
<td>9:00-11:00 (starts wk 5)</td>
<td>G51 (Control Lab)</td>
<td>TBA</td>
</tr>
</tbody>
</table>

Unit Outline

- **Syllabus and Schedule**
  - (see the Unit Outline, pp.5-6)

Unit Outline

- **Assessment information(*):**
  - Class Test (15%): Week 7 Wed 25.8.10
  - Assignment (25%): Week 13 Fri 28.9.10
  - Tutorials (5%): a tutorial notebook is required - submit at the end of semester
  - Practicals/Labs (15%): TBA (from Week 5) Due date of submission - 2 weeks after commencing
  - Exam (40%): TBA
- (*) Any changes will be advised.

Any Questions?

Chapter 1 Introduction

- **Learning Outcomes:**
  - Process control
  - Instrumentation
  - Basic concepts: system, process, open-loop, closed-loop
  - Basic components of a measuring system and a control system
- **Reading:** Chapter 1
Chapter 1: Introduction

- Process control
  - Process: relationship between physical variables
  - Example 1.1
  \[
  q_{\text{out}} = K \sqrt{h} \\
  h = \left( \frac{q_{\text{out}}}{K} \right)^2
  \]

Chapter 1: Introduction

- Human aided control vs Automatic control

Chapter 1: Introduction

- Instrumentation
  - Inventory
  - Quantity management
  - Statistical analysis
  - Test, indication etc.
- Example
  - Tank system
- Overview of history

Chapter 1: Introduction

- Basic concepts:
  - System
  - Signals and Variables

Chapter 1: Introduction

- Example: Variables of a stirred tank

Input variables?
Output variables?
Chapter 1 Introduction

- Open-loop system:
  - No feedback

- Closed-loop system:
  - Feedback signal
  - Comparison of measured OP with Desired Value
  - An illustration of closed-loop control principle

Chapter 1

- Closed-loop system
  - Feedback signal

Chapter 1 Introduction

- Basic components & signals: very complicated control system (e.g. spaceship) can be simplified as the following f.b. diagram

Figure 1.11 An illustration of a heat exchanger when under manual control. The controller and process together form a closed loop of control (represented by the heavy dashed line)

Figure 1.14 Basic components and signals of a feedback control system

Chapter 1 Introduction

- Feedback level control system

Chapter 1 Introduction

- Closed-loop system and energy conversion
Chapter 1 Introduction

• Block diagram showing loop and signal processing

![Block diagram showing loop and signal processing](image1)

Chapter 1 Introduction

• Flow diagram using standard symbols

![Flow diagram using standard symbols](image2)

Chapter 1 Introduction

**Control Media**

• Electrical
• Hydraulic
• Pneumatic
• Thermal
• Mechanical

Most common: combined

![Diagram of control media](image3)

Chapter 1 Introduction

• Case study: Boiler level control system

![Diagram of boiler level control system](image4)

Chapter 1 Introduction

• Case study: Ship and autopilot

![Diagram of ship and autopilot](image5)

Chapter 1 Introduction

• Case study: Ship and autopilot

![Diagram of ship and autopilot](image6)
Chapter 1 Introduction
• Stirred tank with level and temperature controls

Figure 1.3. Process control system for a stirred tank.

Chapter 1 Introduction
• James Watt’s Governor (marine governor)
• Identify input and output variables
• Process variable (to be controlled)?
• Manipulated variable?

Chapter 1 Introduction
• Summary:
  – Basic terms: process control, instrumentation
  – Historical overview
  – Functional block diagram
  – Open-loop, closed-loop systems
  – Basic components and signals
  – Examples of control systems

Any Questions?