Chapter 1

Introduction to Factory Automation

1.1 A hierarchical model of factory automation;
1.2 Control system requirements and automatic control technologies
1.3 Classification of control system based on time and resolution
- **1.3.1** Open loop control system.
- **1.3.2** Closed loop control system.
- **1.3.3** Continuous control systems.
- **1.3.4** Discrete event control systems.

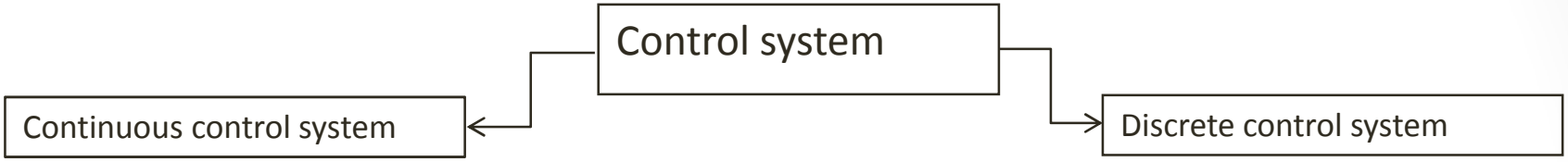
1.1 A hierarchical model of factory automation;

There are four levels of factory automation namely:

1. *Machine level automation*
2. *Production line or work cell automation*
3. *Shop floor automation*
4. *Plant level automation* .

Course Objective Concern On 1st Level.

1.2 Control system requirements and automatic control technologies



Linear : e.g PID controller.

Nonlinear : e.g. MARC, Fuzzy.

Conditional: (Boolean – Expert system)

Sequential : (Temporal – Event)

Continuous: In this case the values to be controlled change smoothly.
Discrete: The value to be controlled can be described as on or off, e.g. room light is switched on or off.
Linear systems: Linear systems can be represented using linear differential equations.
Non-linear systems: This is how the real world behaves, that will complicate the mathematical modeling of a system behavior.
Sequential systems: The logic controller depends not only on time but also on the previous logic condition

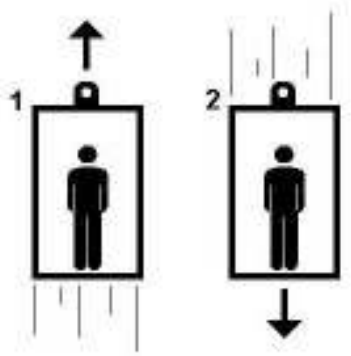
Illustrated Application: **Simple Elevator Problem**

Discrete/sequential:

+ The elevator moved towards a floor when push button is pushed.
+ The elevator open a door when it is at the floor level.
+ The elevator door closed before elevator travel.
+ The elevator door suddenly open when the elevator door is jammed or interrupted by the users.
+….etc.

Linear or continuous:

+ If desired level or position is updated, accelerate quickly towards the required position
+ The elevator slow-down or decelerate when approaching the new position.
+ …etc.



1.3 Classification of control system based on time and resolution

Time refers to how quickly it is necessary to update the information on the system state in order to affect adequate control. Furthermore, a where system changes rapidly, continuous updating of information required.

Resolution refers to the precision with which it is necessary to measure the state of the system. For example, maintain the room temp +/- 1 deg, required high resolutions. Switching a lamp in room ON/OFF does not require high resolution it is just on or off.

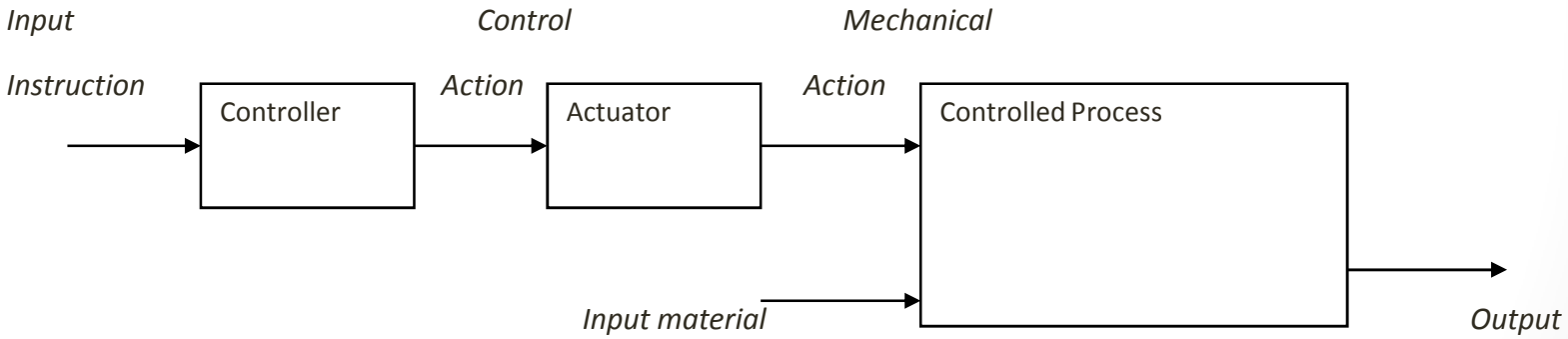


Figure 1.2: Block diagram of open loop control system.

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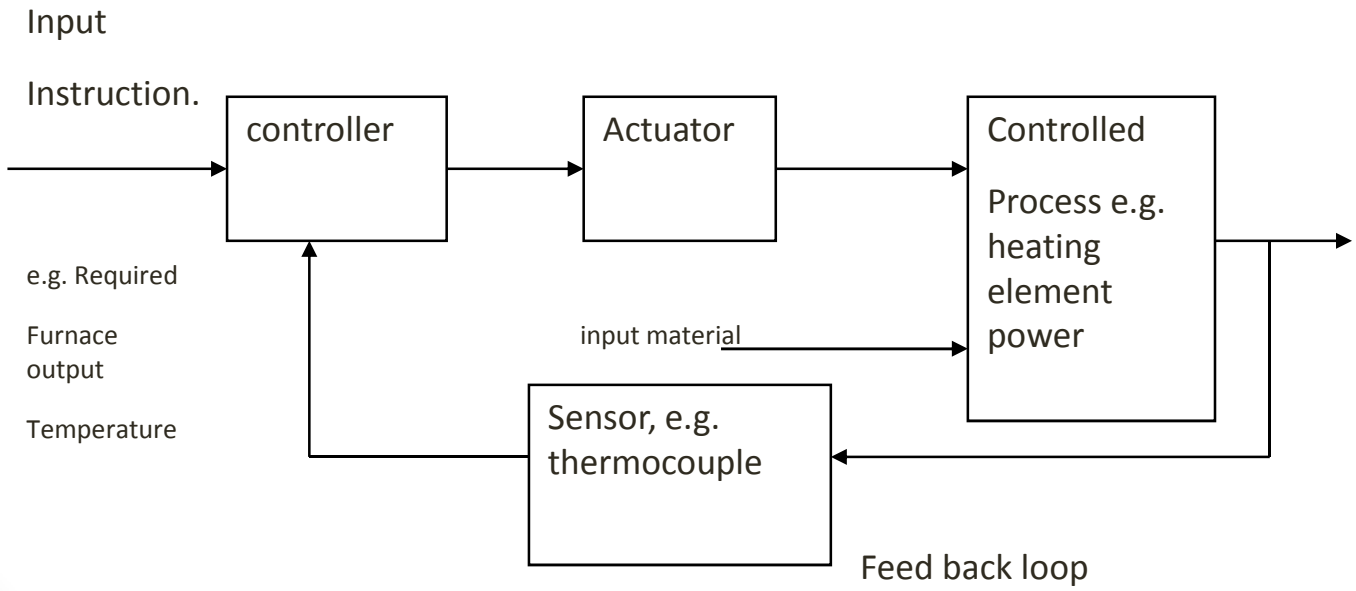


Figure 1.3 Block diagram of closed loop control system.

1.3 Classification of control system based on time and resolution

Continuous control systems.

This type of control system monitors the system control constantly and adjusts the parameters of the control system.

The control system has closed loop plus short time response plus high resolution, e.g. Temp. control in heat treatment furnace problem

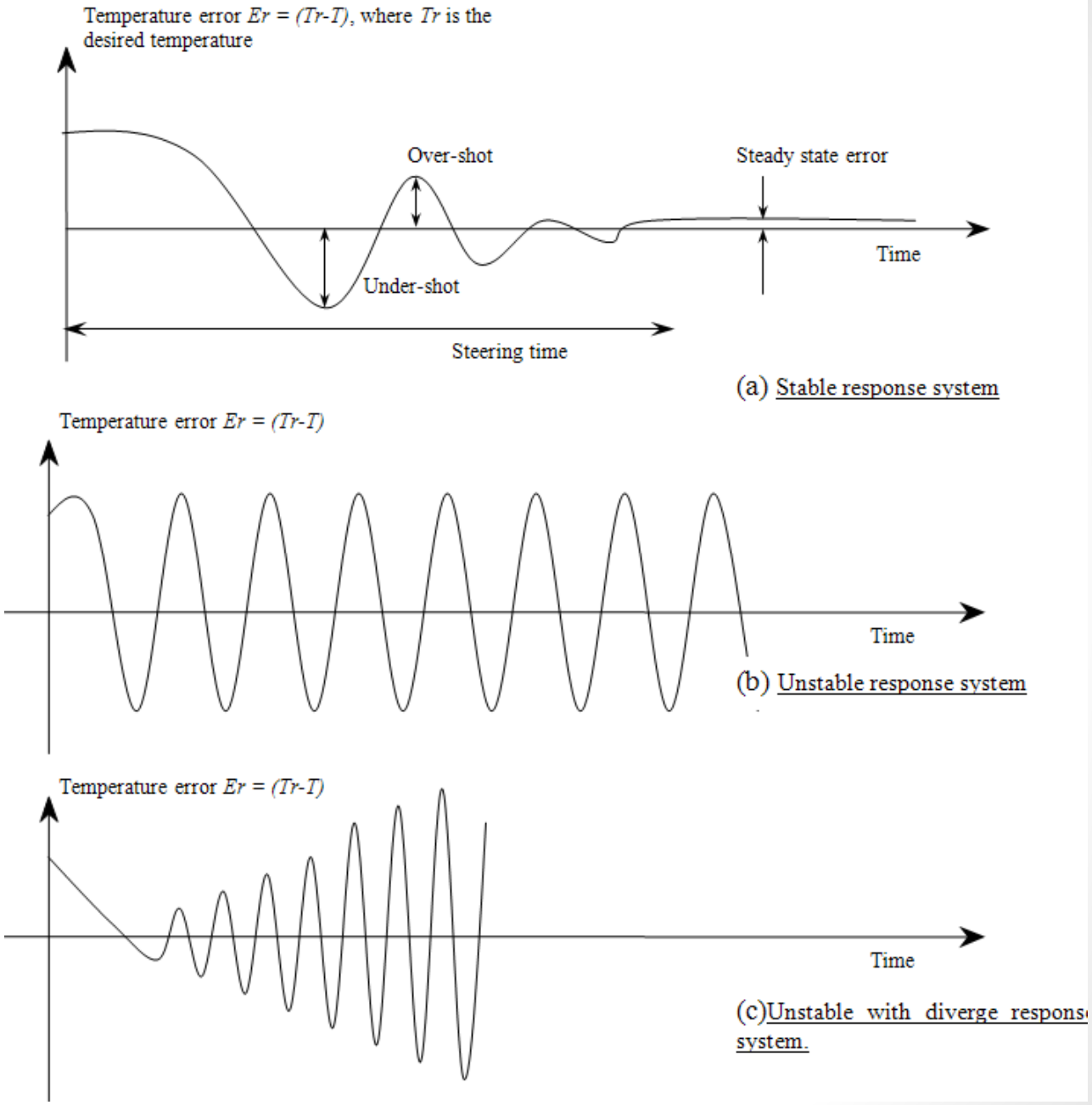
Also possible: open loop (low resolution) plus short time response time. Bench mounted room heater problem.

Discrete event control systems.

In this control systems, the system often does not require time-critical control specifications or high-resolution measurement, but just the existence of closed loop control or even open loop control.

e.g. Hooper filling problem can be open loop or closed loop system.

Continuous and Closed loop Linear Control System Response (PID controller)



Discrete open and closed loop control systems – **Illustrated Applications**

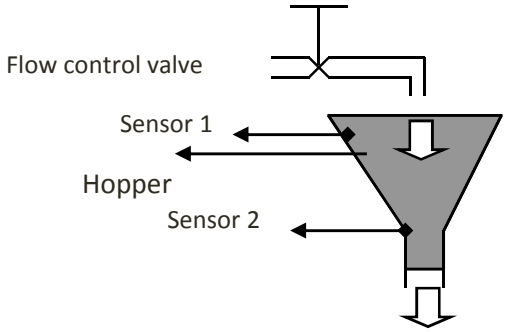


Figure 1.5 Hopper control through discrete event system.

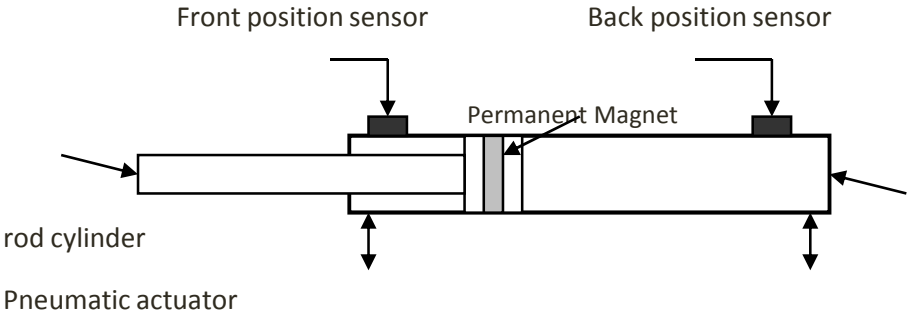


Figure 1. 6 Pneumatic cylinder position control problem.

Exercises

1.1) Suggest control actions (discrete/continuous) for the following actuator/sensors. Provide an example/examples for each case.
   a. Linear displacement of a hydraulic cylinder forward and backward positions.
   b. Angular displacement of a DC motor.
   c. Movement of belt conveyer.
   d. Linear displacement of an electric solenoid.

1.2) Suggest the control system for the following control applications;
   a. Temperature controller in heat treatment furnace.
   b. Position controller of machine tool.
   c. Can filling controller on a belt conveyer.
   d. Door locking controller in an automobile.

1.3) State the main differences between discrete and continuous control system?

1.4) "Two parameters of system control influence kind of automatic control required (1) Time and (Precision". Explain this statement with illustrated examples?

1.5) "Double-acting pneumatic cylinder is a pneumatic actuator is commonly used in different assembly machines. This type of actuator usually used to control machine operation either in closed or open loop discrete control systems". Explain how we can use this type of actuator as closed and open loop control systems?