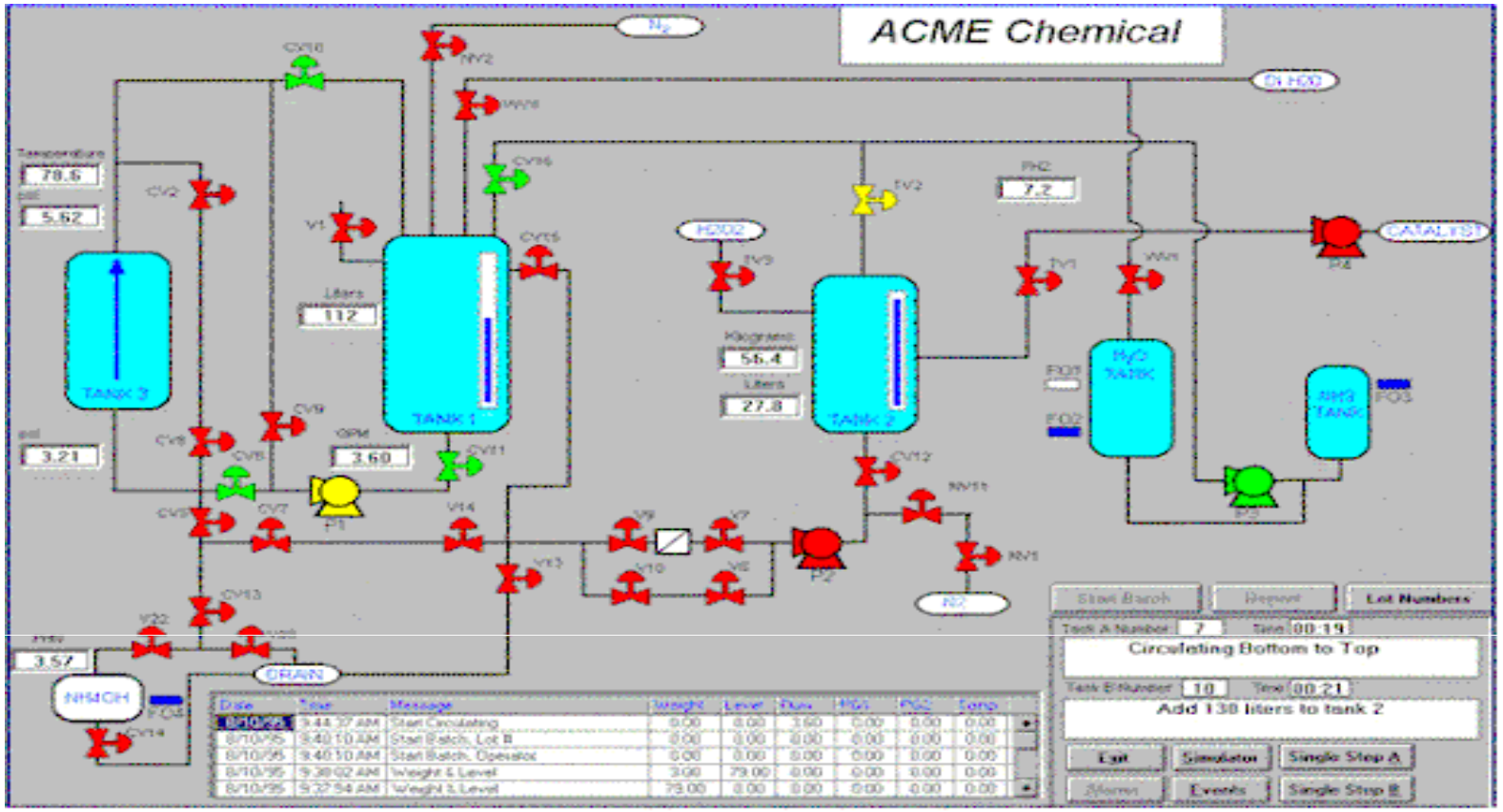


Advanced Automation System (EE 710)

Lect.2: Industrial control system and PLC Fundamentals

Presented by Dr. Mostafa Abdel-Geliel

Course topics:

- Introduction
- Automation definition and components
- **Industrial control system and PLC Fundamentals**
- Advanced PLC programming
- Industrial communication
- Communication Protocol and standard
- SCADA and Human Machine interface (HMI)
- DCS Fundamentals
- Applications

Chapter 2: Industrial control system and PLC fundamentals

Outline:

- IProcess components
- Automation definition
- Automated system objectives
- Automated system components
- Types of control strategies
- Examples of automated processes
- Automation hierarchy

Types of Control

- Just as there are two basic types of variables and parameters in processes, there are also two corresponding types of control:
  - Continuous control - variables and parameters are continuous and analog
  - Discrete control - variables and parameters are discrete, mostly binary discrete

Continuous Control

- Usual objective is to maintain the value of an output variable at a desired level
  - Parameters and variables are usually continuous
  - Similar to operation of a feedback control system
  - Most continuous industrial processes have multiple feedback loops
- Examples of continuous processes:
  - Control of the output of a chemical reaction that depends on temperature, pressure, etc.
  - Control of the position of a cutting tool relative to workpart in a CNC machine tool

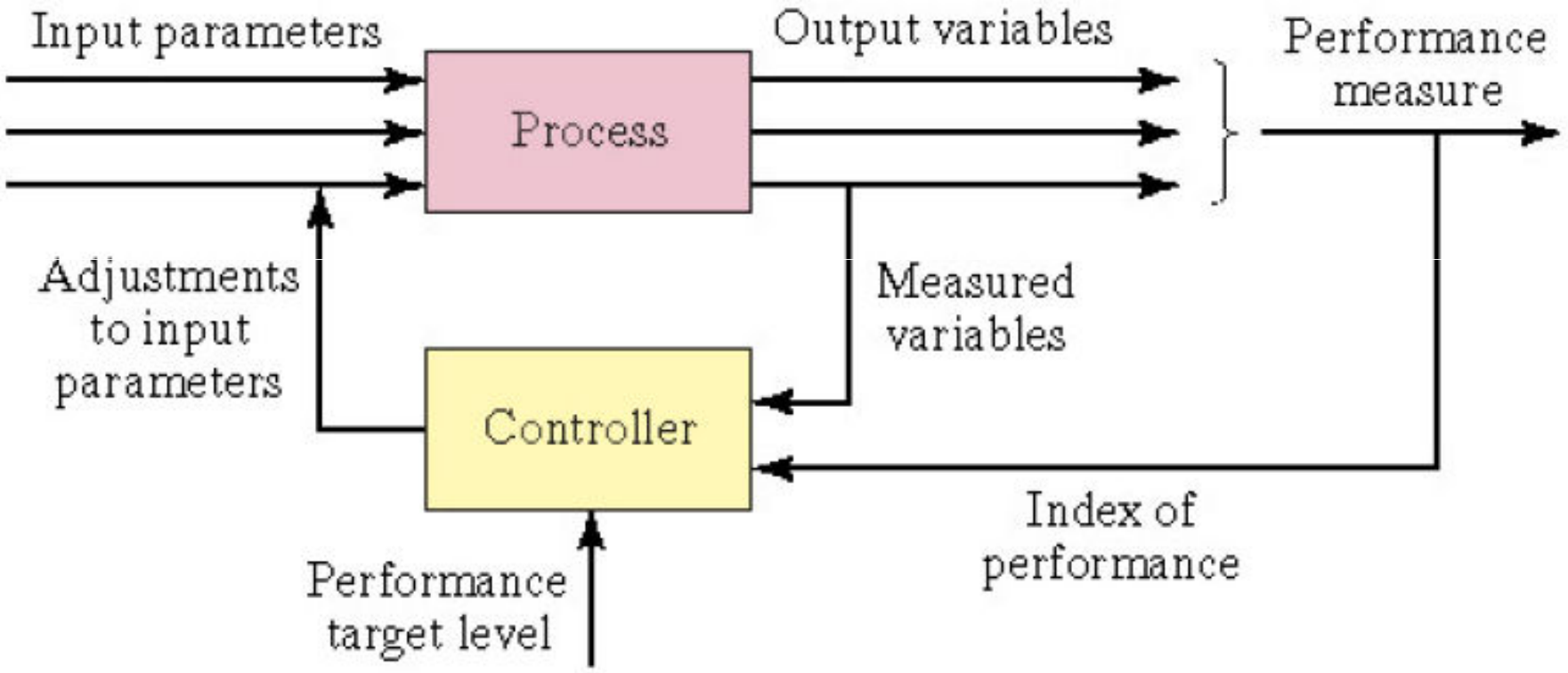
Types of Continuous Process Control

- Regulatory control
- Feedforward control
- Steady-State optimization
- Adaptive control
- On-line search strategies
- Other specialized techniques
  - Expert systems
  - Neural networks

Regulatory Control

- Objective - maintain process performance at a certain level or within a given tolerance band of that level
  - Appropriate when performance relates to a quality measure
- Performance measure is sometimes computed based on several output variables
  - Performance measure is called the *Index of performance* (IP)
- Problem with regulatory control is that an error must exist in order to initiate control action

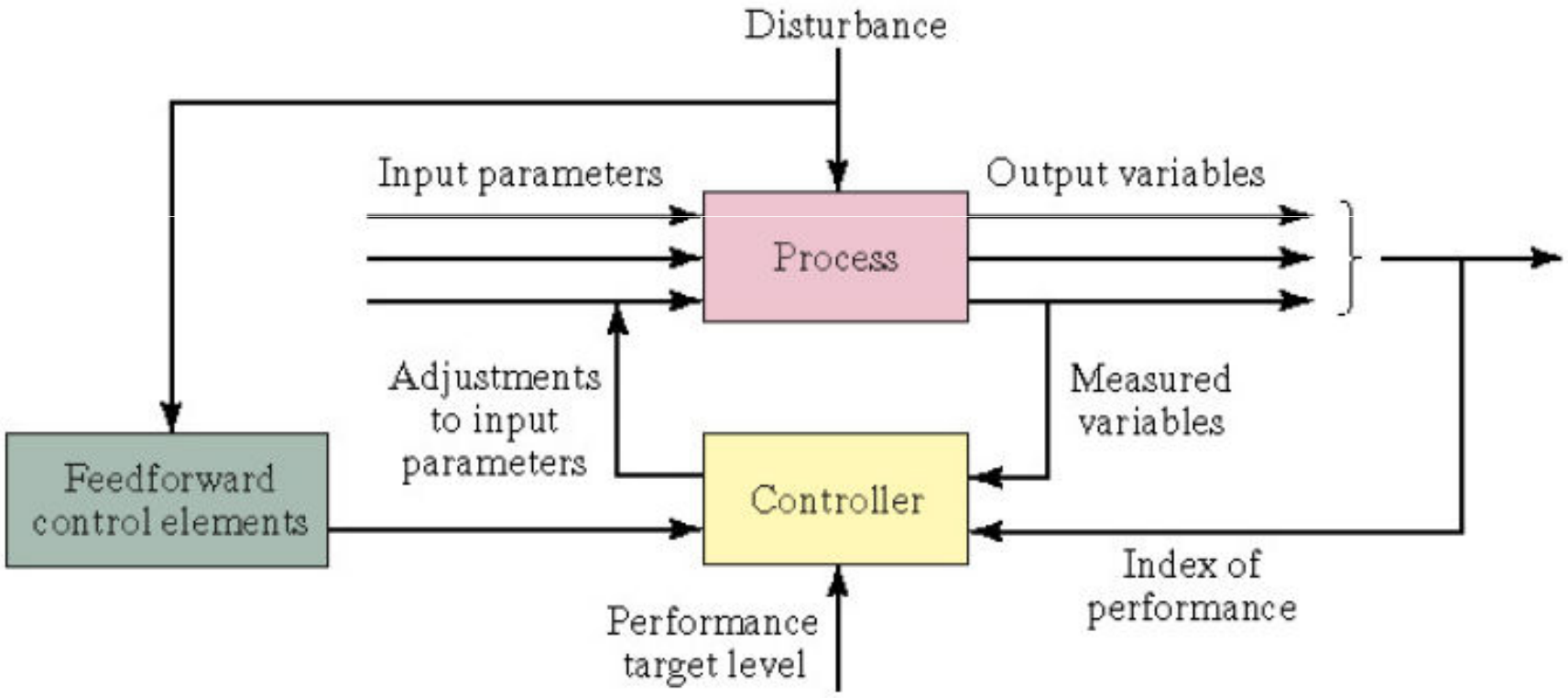
Regulatory Control



Feedforward Control

- Objective - anticipate the effect of disturbances that will upset the process by sensing and compensating for them before they affect the process
- Mathematical model captures the effect of the disturbance on the process
- Complete compensation for the disturbance is difficult due to variations, imperfections in the mathematical model and imperfections in the control actions
  - Usually combined with regulatory control
- Regulatory control and feedforward control are more closely associated with process industries

Feedforward Control Combined with Feedback Control



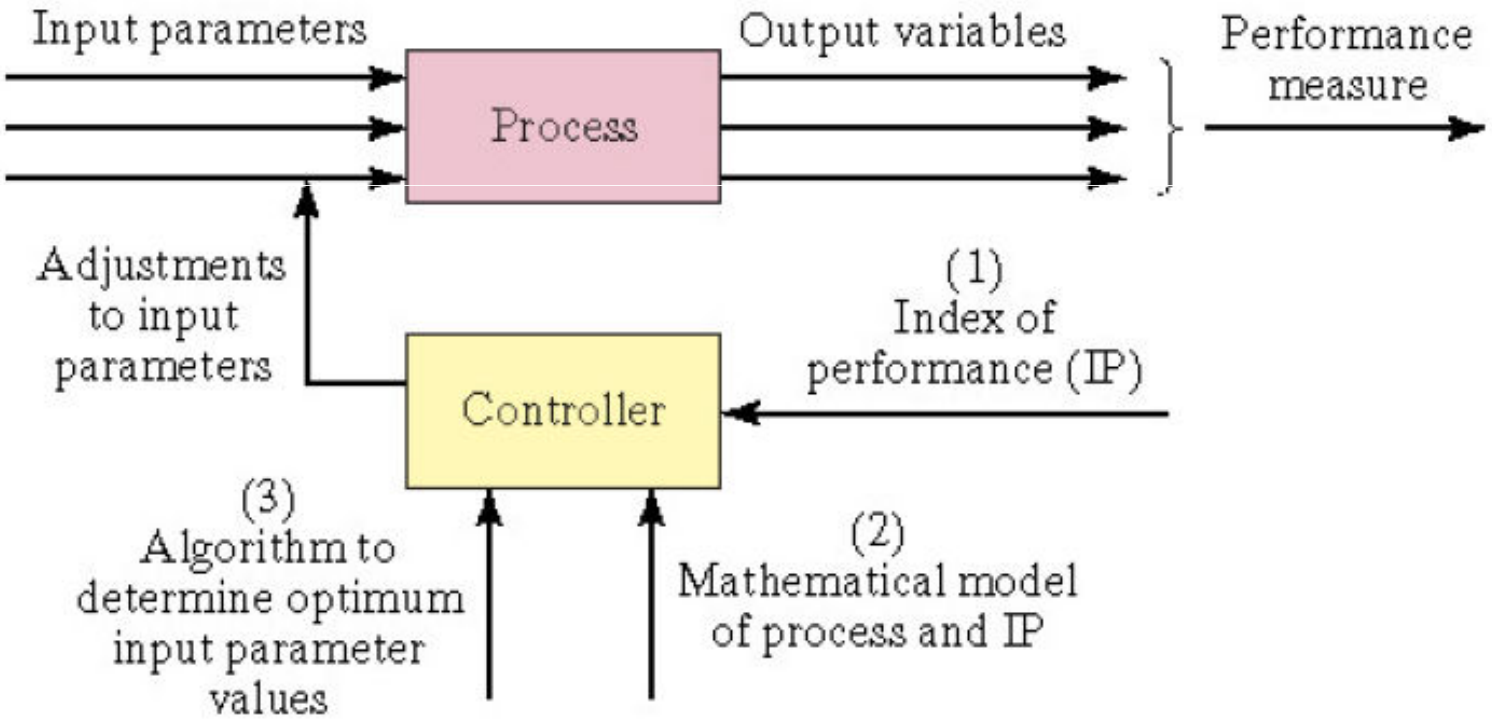
Steady-State Optimization

Class of optimization techniques in which the process exhibits the following characteristics:

1. Well-defined index of performance (IP)
2. Known relationship between process variables and IP
3. System parameter values that optimize IP can be determined mathematically

- Open-loop system
- Optimization techniques include differential calculus, mathematical programming, etc.

Steady State (Open-Loop) Optimal Control



Adaptive Control

- Because steady-state optimization is open-loop, it cannot compensate for disturbances
- Adaptive control is a self-correcting form of optimal control that includes feedback control
  - Measures the relevant process variables during operation (feedback control)
  - Uses a control algorithm that attempts to optimize some index of performance (optimal control)