Module # 1.3

INTRODUCTION
Process Dynamics

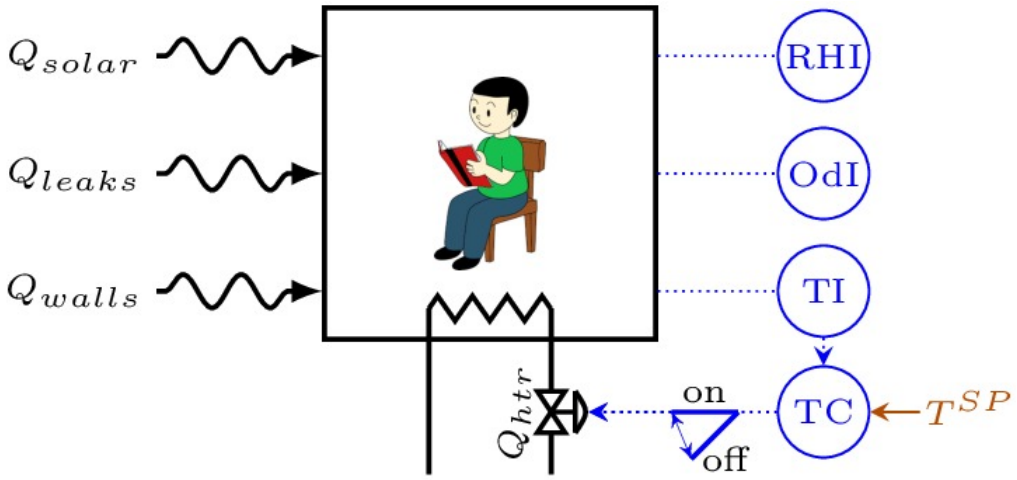
Lectures on

CHEMICAL PROCESS CONTROL
Theory and Practice

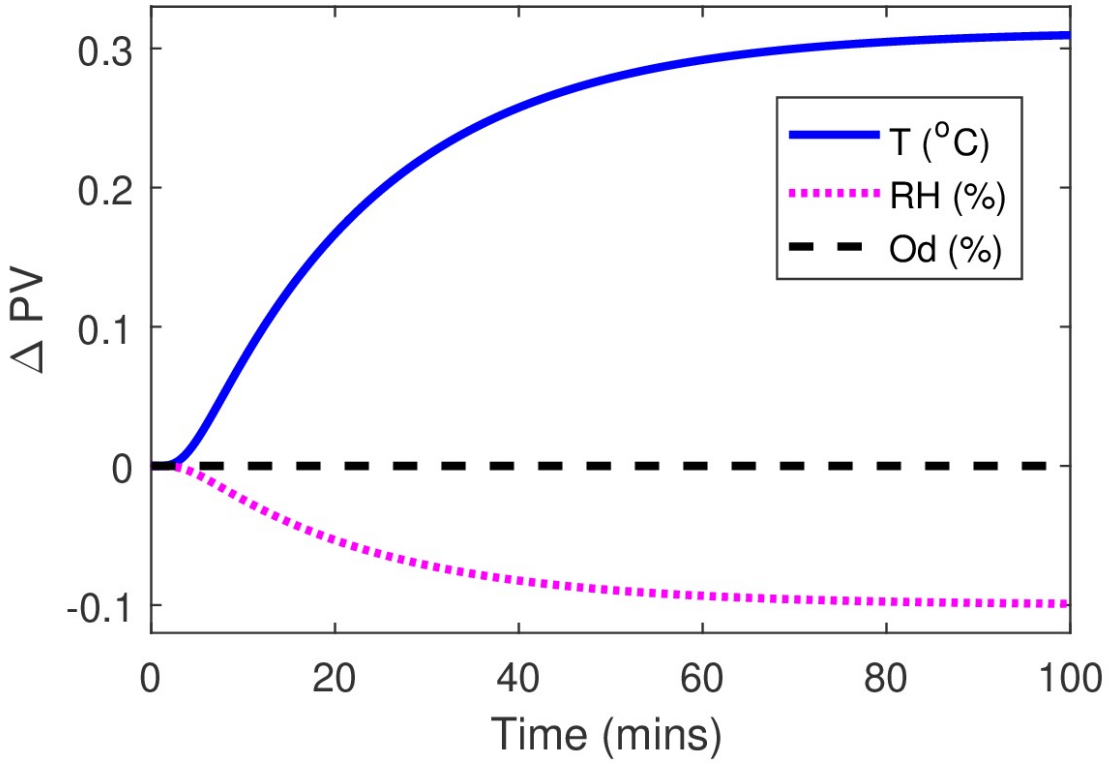
Process Dynamics

- Output PV trajectory over time in response to input PV changes
  - Process with no control
  - Process with a control system installed

ROOM EXAMPLE



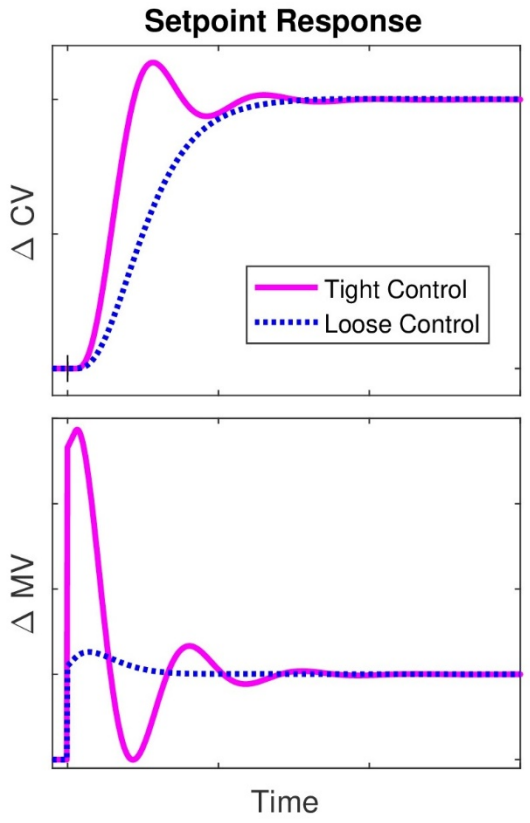
Output PV Dynamics: No control



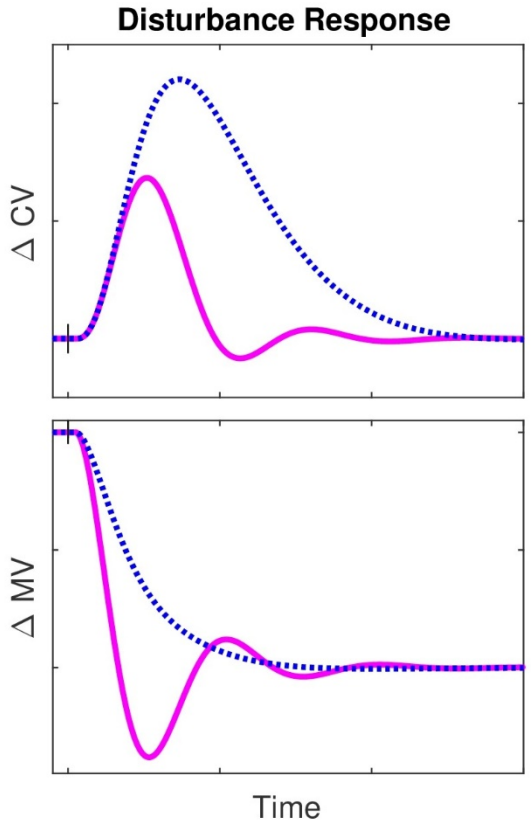
Dynamics with Control

- Two types of responses
  - Response to a CV setpoint change (SERVO)
  - Response to a disturbance change (REGULATOR)

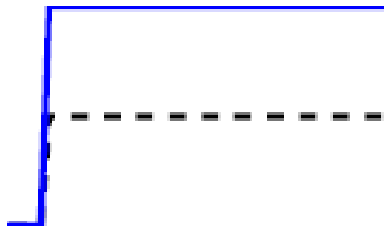
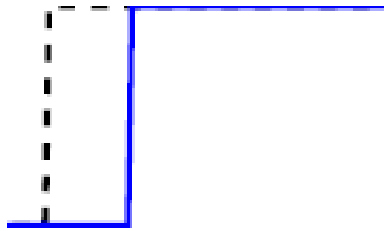
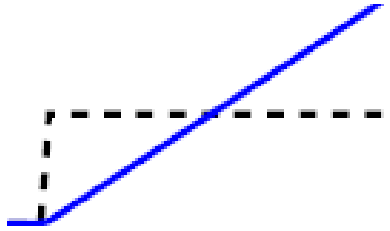
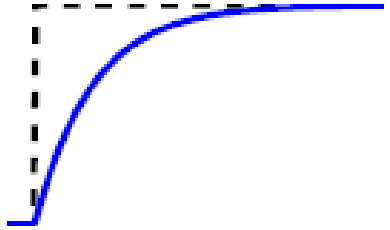
SERVO



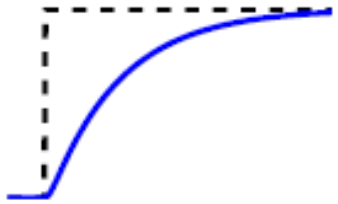
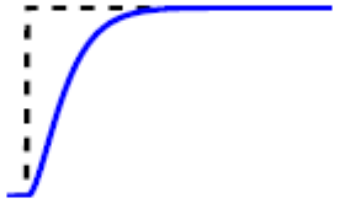
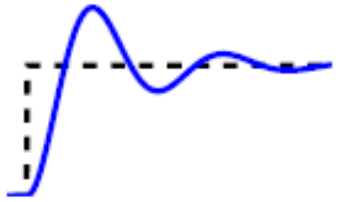
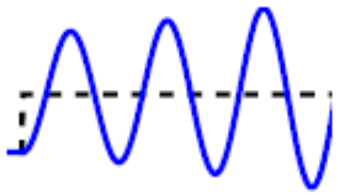
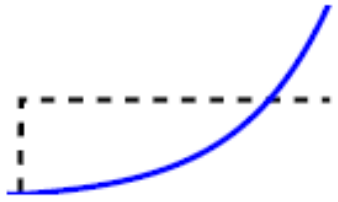
REGULATOR



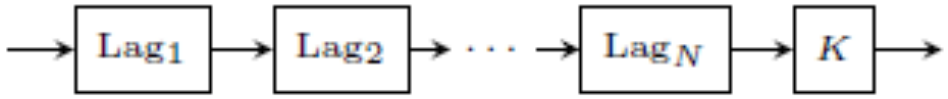
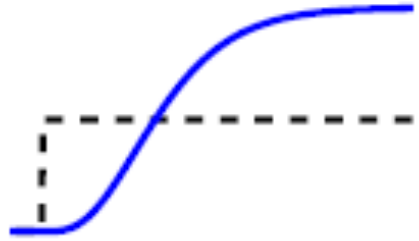
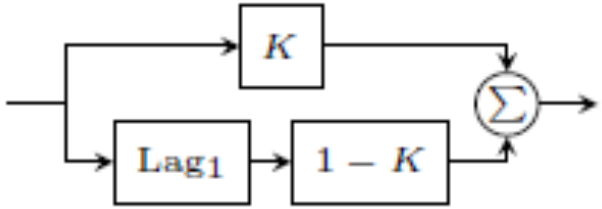
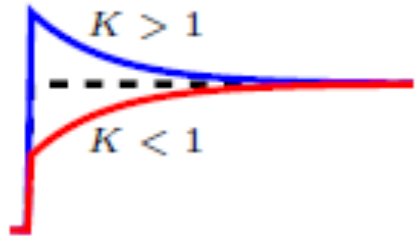
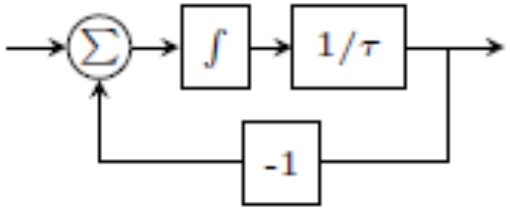
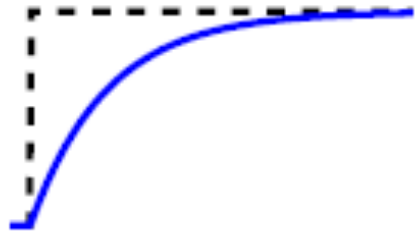
Basic Dynamic Responses

Pure Gain	
Pure Delay	
Integrator	
Lag	

Basic Dynamic Responses

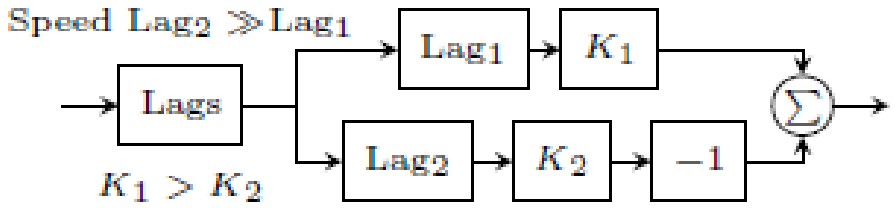
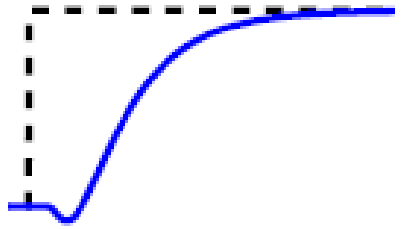
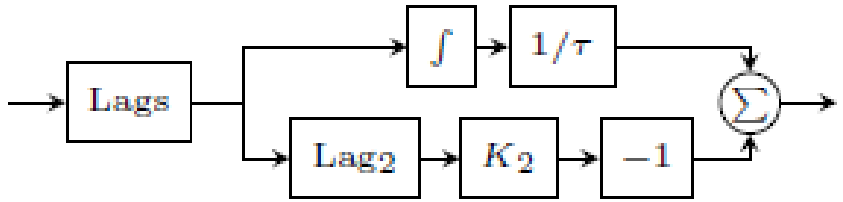
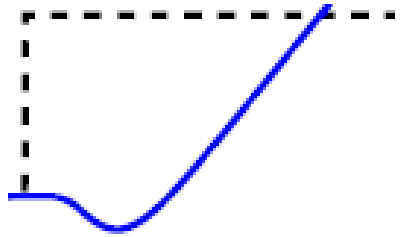
2nd order overdamped	
2nd order critically damped	
2nd order underdamped	
Unstable oscillatory	
Unstable non-oscillatory	

Complex Responses by Combining Basic Responses

Lags in Series		
Lead-Lag		
Lag from Feedback		

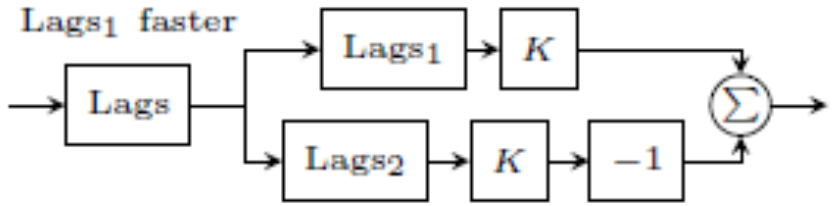
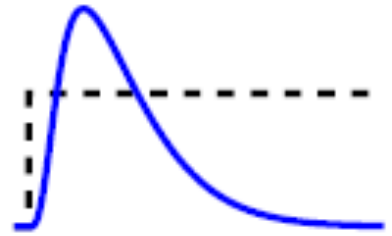
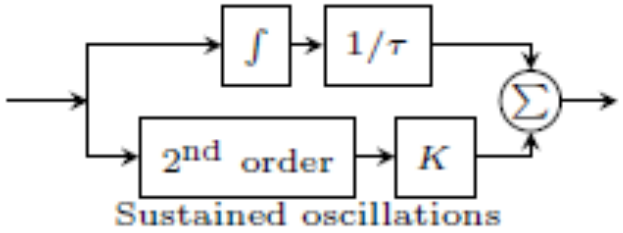
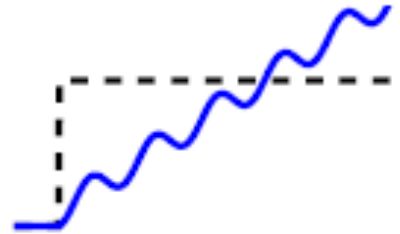
SERIES, PARALLEL & FEEDBACK STRUCTURES

Complex Responses by Combining Basic Responses

Inverse Response		
Inverse + Integrator		

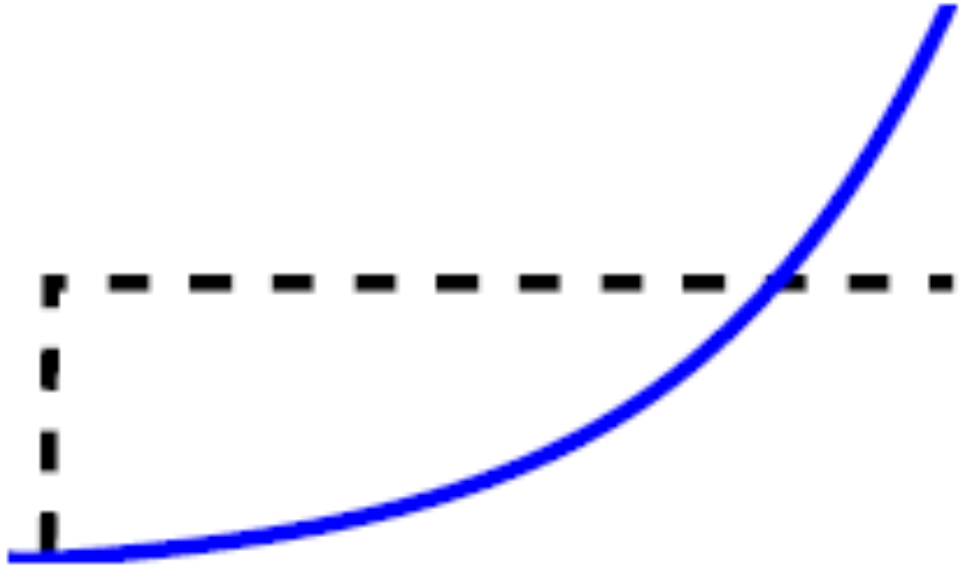
Examples in Nature?

Complex Responses by Combining Basic Responses

Pandemic		
Rippling Ramp		

Examples in Nature?

Exercise: Combining Basic Responses



Real-life example?

Summary

- Nature exhibits a variety of dynamic responses
- The variety of responses well represented by a combination of basic dynamic response elements
  - Series
  - Parallel
  - Feedback or recycle
- The basic dynamic response elements
  - Pure gain
  - Pure dead time
  - Pure integrator
  - First order lag
  - Second order lag