Process Dynamics and Control

Ali M. Sahlodin
Department of Chemical Engineering
AmirKabir University of Technology

دانشگاه صنعتی امیرکبیر
(پلی تکنیک تهران)

About Me

- Ali M. Sahlodin (علی محمد سهل الدین)
  - BSc, University of Tehran (1384).
  - MSc in Simulation and Control, Sharif University of Technology (1386).
  - PhD in Process Optimization, McMaster University (1391).
  - Postdoc in Dynamic Optimization, Massachusetts Institute of Technology (1392-1394).
  - Sr. Engineer, Aspen Technology (1394-1397).

Office location: 4th floor
Email: sahlodin@aut.ac.ir

2

About You!

- Let's get to know you!

3

Teaching Method

- Powerpoint slides/chalkboard/whiteboard
  - Slides may be available before/after the class.
- Use of Software as appropriate
- Class discussions

4

Evaluation and Examination

- Assignments: 30%
- Midterm (closed) 30%
- Final (closed): 30%
- Quiz: 10%

- Midterm date/time

To be announced by the undergrad. office

Course involves working with MATLAB/Simulink

5

TA Sessions

- Solving sample problems
- Helping with assignments (start working on it **before** you show up)

- Attendance mandatory

- Mr. Azghandi
  - azghandimohammad@aut.ac.ir

6

Class Rules

- **Attendance** required (the **3/16** rule).
- **Attention** requested.
- Questions may be asked at any time.
  - **Don't be afraid of your English**
  - **Remember: no question is naïve!**
- **Assignments**
  - Assignments must be submitted in a **single PDF** via LMS (**no hardcopy**)
    - Email **only** if LMS closed (include student # in subject line)
  - Late assignments may be penalized.
  - Too late submissions will **NOT** be accepted.

7

How To Get A Good Grade (Easily)

- Be present **physically** (and be on time)
- Be present **mentally**
  - Got something funny to tell? **Save** it for later!
  - Falling **asleep**? Stand up and stretch out☺
- Understand the **concepts**
- Ask questions
- Get involved
- Do the assignments
- Attend the TA class

8

No-Haggling Policy

- Common REASONS/EXCUSES (not accepted)
  - It's my last semester and I need to graduate
  - Process Control won't be my future concentration
  - I'm changing my major altogether!
  - I need extra marks to get a higher GPA
  - I focused on problem solving and missed the concepts
  - I focused on the concepts and didn't practice problem solving
  - I did well in the midterm or the final.

9

Academic Integrity

- **Assignments**:
  - Group discussions are encouraged, but write-ups must be done independently.
  - Do not procrastinate; be ahead of time!
- **Citation**:
  - Acknowledge the source (even if your own work).
  - Never copy a sentence unless you use quotation and give proper citation.
  - Cite credible sources (No Wikipedia please!)

10

PROCESS DYNAMICS AND CONTROL

Welcome to the course!

11

Course Outline

- Introduction to process control
- Dynamic models of chemical processes
- Dynamic behavior of processes
- Laplace transforms
- Dynamic response of certain systems

Process Dynamics

- Feedback control
- PID control
- closed-loop stability analysis
- Enhanced control loops

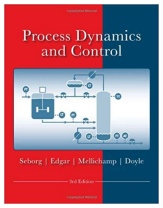
Process Control

12

References

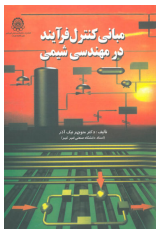
Process Dynamics and Control

3rd Edition. John Wiley & Sons, Inc. 2010. Dale E. Seborg, Duncan A. Mellichamp, Thomas F. Edgar, Francis J. Doyle III.



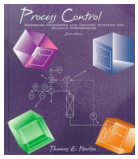
مباني كنترل فرآيند در مهندسي شيمي

دكتر منوچهر نيک آذر، انتشارات دانشگاه اميركبير



Process Control: Designing Processes and Control Systems for Dynamic Performance (free)

Thomas Marlin, 2nd Ed. McGraw-Hill Education



13

What is Process Dynamics?

Unsteady-state behavior of processes

- Batch and semi-batch processes
  - Inherently dynamic
- Transient course in continuous processes
  - Product grade transition
  - Startup/shutdown
  - Process upsets and disturbances

Steady-state operation is only an **exception, not the rule**!

14

What is Process Control?

What do we do in process design?

- **Process Design**: Obtain process layout, equipment sizing and *steady-state* operating conditions.
- **Process Control**: how we reach those operating conditions and stay there

15

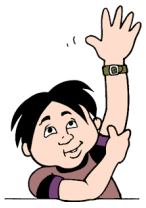
3 Myths about Process Control

- It's an electrical engineering subject
- It's not useful if you want to go to industry
- It's hard to learn
- More?!

16

Examples of Control Systems

- Don't get ChemE. yet!



Day-to-day control examples

- Control of temperature in air conditioners
- Control of screen brightness in smart phones
- Control of speed (cruise control) in cars
- Control of blood sugar in body (using insulin)
- Autopilot in air planes
- …

17

Examples of Process Control

- Level control in a tank
- Temperature control in a reactor
- Flow control
- …

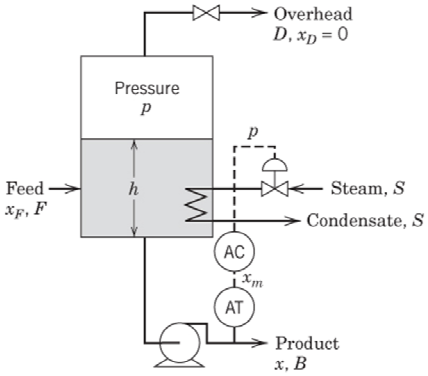


Figure E8.14

Seborg et. al Process Dynamics and Control

18

Basic Definitions

- **Controlled variable**: the variable we want to keep at a certain value or follow a certain trajectory.
- **Manipulated variable**: the variable we adjust in order to control the controlled variable.
- **Disturbance variable**: the variable that impacts the controlled variable, but cannot be manipulated.
- **Set point**: the point which we want to keep the controlled variable at.

Revisit your examples and specify these variables in each of them.

19