Introduction to the course "Advanced Process Control"

Prof. Gabriele Pannocchia

Department of Civil and Industrial Engineering (DICI)
University of Pisa, Italy
Email: gabriele.pannocchia@unipi.it

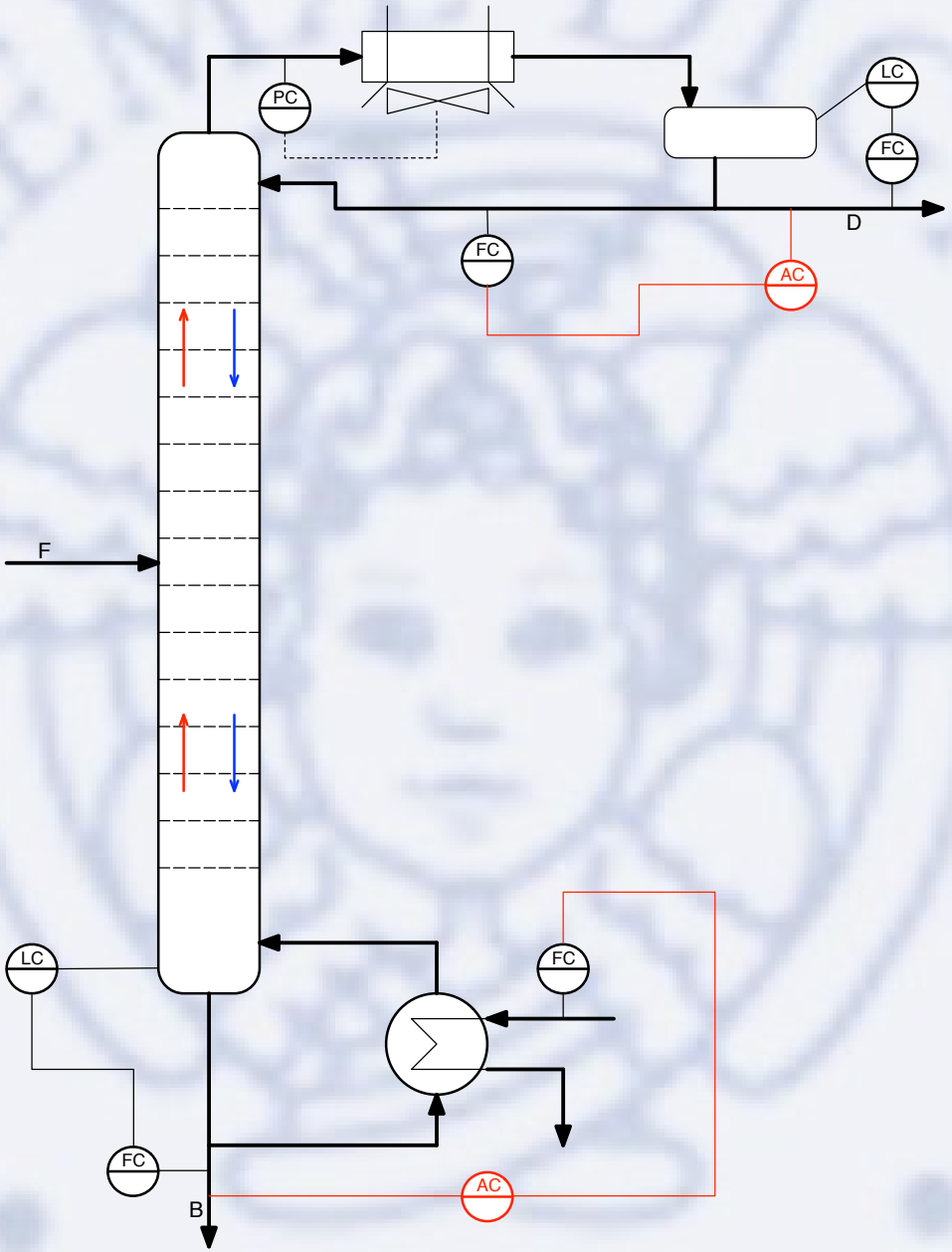
Second Year course, MS in Chemical Engineering
University of Pisa, Academic Year 2017-2018

Outline

1. An overview on advanced process control problems

2. Course presentation
   - General information
   - Objectives and methodology
   - Syllabus
   - Course material
   - Student office hours
   - Examination

An example of multivariable process control system



General information

Course teacher

- Prof. Gabriele Pannocchia
- Department of Civil and Industrial Engineering (former Dept. of Chemical Engineering section)
- Office @ 2nd floor (1 floor down main entrance), room 201
- Telephone: 050 2217 838
- Email: gabriele.pannocchia@unipi.it
- Web Site: `https://people.unipi.it/gabriele_pannocchia/`

Objectives and methodology of the course

Course objectives

The course will allow the students to understand:

1. What are the process control issues and problems in large-scale, multi-variable process systems
2. How a hierarchical planning, optimization and control system is organized
3. How economic performance can be sustained

Course methodology

- Lectures (about 70% of time)
- Class exercises and simulation sessions (about 30% of time)
- Homework assignments (Graded)

Course syllabus (1/2)

Part I: Introduction to multivariable systems (15 hours)

1. Systems theory for multivariable systems (continuous time)
2. Interaction analysis and loop pairing techniques
3. Directionality, decouplers and robustness
4. Samples of ”conventional” advanced control systems

Part II: Model Predictive Control (20 hours)

5. Systems theory for multivariable systems (discrete time)
6. Optimal LQR/LQG theory
7. MPC: theory and implementation
8. MPC: industrial examples

Course syllabus (2/2)

Part III: Systems identification (8 hours)

9. Conventional data collection and identification methods
10. Advanced data collection
11. Advanced identification methods

Part IV: Soft sensing and inferential control (7 hours)

12. Product quality control issues
13. Soft sensors: theory and methods
14. Closed-loop consistency and soft sensor update

Part V: Performance monitoring (5 hours)

15. Monitoring issues and methods for regulatory controllers
16. Monitoring methods for MPC

Course material (1/2)

Books

- Babatunde A. Ogunnaike and William H. Ray *Process Dynamics, Modeling, and Control* Oxford University Press, 1994.
- João P. Hespanha. *Linear Systems Theory*. Princeton University Press, 2009.
- James B. Rawlings and David Q. Mayne. *Model Predictive Control: Theory and Design*. Nob Hill Publishing, 2009.
- Jan M. Maciejowski. *Predictive Control with Constraints*. Prentice Hall, 2002.
- Lennart Ljung. *System Identification: Theory for the User*. Prentice Hall, 1999.
- Yucai Zhu. *Multivariable System Identification for Process Control* Springer, 2001.
- A. Brambilla. *Distillation Control and Optimization*. Mc. Graw Hill Education, 2014.

Course material (2/2)

Lecture slides and additional material

The following material will be available incrementally at the Engineering E-learning web site:

`http://elearn.ing.unipi.it/course/view.php?id=1131`

- Lecture slides
- Simulation files
- Scientific articles

Student office hours and list

Student office hours

- Students office hours on Monday 14:00-16:00
- Presence must be confirmed by email
- Quick questions can also be asked/answered by email

Student list

- Each student must be enrolled in the course at the E-learning site
- All communications will be sent via email from E-learning (make sure your address at E-learning is up to date)

Examination

Examination scheme

- Step 1 - Homeworks (Simulation, Theory): 50%
- Step 2 - Oral exam (Theory): 50%