DINAMICA E CONTROLLO DEI PROCESSI CHIMICI

**Laurea Magistrale Interclasse in Ingegneria di Processo e dei Materiali
A.A. 2019-2020
UNIVERSITA' DEGLI STUDI DI TRIESTE**

MolBNL
MOLECULAR BIOLOGY AND NANOTECHNOLOGY LABORATORY
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BRAINSTORMING

WHAT DO YOU EXPECT FROM THIS COURSE?
Skills to gain, challenges to face, topic to learn, …

WHAT DO I EXPECT FROM YOU IN THIS COURSE?

EXPECTATION

REALITY

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COURSE OBJECTIVES

- Understanding how to analyze the **dynamic behavior** of a process subject to:
  - ▻ **intentional changes** to the operating variables
  - ▻ **undesired events** («disturbances»), which can perturb nominal operation of the process
- Developing **dynamic models** to simulate the behavior of simple and (moderately) complex systems:
  - ▻ Using **prior knowledge** of the process (*e.g. dynamic material/energy balance equations, constitutive equations, …*)
  - ▻ Using process **measurements** only
- Understanding how the equipment **design parameters** and the process **operating conditions** can affect the dynamic response of the system:
  - ▻ Knowing in advance how a process will perform **in the future**

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COURSE OBJECTIVES

- Understanding how **a process control system** works:
  - ▻ Which variables should be **«controlled»** to ensure that the process is operating satisfactorily?
  - ▻ Which variables should be **«manipulated»**, and how, to reject perturbations?

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COURSE OBJECTIVES

- Develop the dynamic model of (simple) processing units
- Identify which design parameters or operating conditions the dynamic response of a process depends upon
- Quantitatively characterize the dynamic response of a system to a change in the inputs
- Understand how control systems work for single processing units and for plantwide systems
- Design feedback and feedforward control schemes for processing units
- Tune a PID controller
- Size a control valve

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COURSE ORGANIZATION

- The course is assigned 9 credits (9 CFU)

  ▷ 9 credits x 25 hr/credit = 225 study hours

    ❖ ~ 72 «frontal» hours including:
      - Standard lectures (theory)
      - Blackboard exercises (application of theory)
      - Computer exercises (Simulink & Aspen)
    ❖ ~ 153 ≈ 72*2 individual study hours, including:
      - Studying the material presented in classes
      - Answering the auto-evaluation questions
      - Solving self-assigned exercises
      - Solving the assigned homework

Notice that 1 class hour is expected to be followed by 2 individual study hours!

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COURSE TIMETABLE

- Starting from Tuesday 10/03, every Tuesday you will find a link inside the course page on Moodle.
  The link will redirect you to the registration of the lessons of the week.

- The last lesson will contain some easy questions regarding the content of the weekly topics. Try to answer them individually, as it will help your self-assessment. You don't need to send me the answers.

- You can watch the lessons whenever you want before Friday, when you can write me an email regarding your doubts and questions. I will evaluate if answering you straightforward, or organize a Q&A session the next Monday, with everyone connected on Skype. In this case, the Skype sessions will start at 14.00.

Week1		Week 2			Week 3			…
09/03	12/03	16/03	17/03	20/03	23/03	24/03	27/03	…
Monday	Wednesday	Monday	Tuesday	Friday	Monday	Tuesday	Friday	…
Lessons of week 0	Lessons of week1	Q&A on weeks 0-1	Lessons of week 2	Questions on week 2	Answers on week 2	Lessons of week 3	Questions on week 3	…

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TEACHING MATERIAL

- Prerequisites
  - ▻ Steady-state material and energy balances
  - ▻ Unit operations of the chemical process industry
  - ▻ Elementary chemical reaction engineering
- Reference textbook: SEMD
  - ▻ Seborg, D.E., T.F. Edgar, D.A. Mellichamp and F.J. Doyle (2017). *Process Dynamics and Control* (4th ed.). Wiley, Hoboken (NJ; USA)
- Additional learning material:
  - ▻ PDF containing the slides and texts of exercises discussed in class
  - ▻ Glossary on process dynamics and control (English-to-Italian)
  - ▻ Simulink examples

- Reference software:
  - ▻ Simulink (under Matlab platform)
  - ▻ PCM-Process Control Modules (under Matlab platform)
  - ▻ AspenPlus

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ADDITIONAL TEACHING MATERIAL

- Consultation of additional textbooks may be useful
  - ▻ Smith, C.A. and A. Corripio (2006). *Principles and Practice of Automatic Process Control* (3° edition). Wiley, New York (U.S.A.)
  - ▻ Ogunnaike, B.A. and W.H. Ray (1994). *Process Dynamics, Modeling, and Control*. Oxford University Press, New York (U.S.A.)
  - ▻ Riggs, J.B. and M.N. Karim (2008). *Chemical and bio-process control* (3° edition). Pearson Education International, Boston (U.S.A.)
  - ▻ *Practical process control* by Control Guru: http://controlguru.com/table-of-contents

- MacMaster University Process Control Education website
  - ▻ http://www.pc-education.mcmaster.ca
    - ❖ Includes interactive learning resources and a process control textbook

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HOW TO STUDY THIS COURSE

- You are strongly invited to study throughout the entire course
  - ▻ 2 homework activities will be assigned
    - ❖ They must be solved individually
  - ▻ Self-assignment of some exercises is strongly suggested
    - ❖ The reference book includes a very large number of exercises
    - ❖ Self-assigned computer exercises (Simulink) may also be useful
- The learning process starts during the viewing of the lessons
  - ▻ Please answer individually the autoevaluation questions
  - ▻ If you would like to receive any comments from me after you answer the questions, just forward me your answers by email

LET'S MAKE A DEAL

- I will do my best to carefully prepare and deliver each single class.

- You will do your best to engage yourself and be an active learner

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NEED HELP?

- For any doubts or clarifications on the course material, please contact me by email.
  - ➤ amio@units.it
  - ➤ If, during your study, you need further explanations, please describe me your doubts by email and I will try to clarify them on Monday sessions
  - ➤ If your doubt is hard to explain, we will arrange a skype call just to explain me your issue. Then, next Monday, we will discuss about it with everyone connected online

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PASSING THE EXAM - HOMEWORK

- 2 Homework activities
  - ➤ They must be solved individually tipically within 2 weeks. A detailed report must be given.
  - ➤ You will earn 1 extra point to the total overall grade for each correct exercise & report you provide on time.
  - ➤ If you fail to provide a correct exercise & report, you have one extra week after the deadline to fix it and gain 0.5 point.
  - ➤ If you don't deliver the report on time, you have one week after the deadline to provide a correct report and gain 0.5 point. You won't have the opportunity to fix it.
  - ➤ In all other cases, you won't get any extra point.

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PASSING THE EXAM - PROJECT

- An individual project will be given to each of you:
  - ➢ You will have to design, draw, tune and test the performances of a control system of a unit operation or a set of unit operations.
  - ➢ You will have to use Simulink as simulating software.
  - ➢ You will provide a detailed report showing the procedures, assumptions, test performed and results. Moreover, the simulation file must be provided.
  - ➢ You will gain a grade assessing your report in terms of:
    - ❖ Correctness of the final solution
    - ❖ Clarity and synthesis in the presentation of the results
    - ❖ Appropriateness of the use of terminology
    - ❖ Rigor of calculation methodology
  - ➢ You will have the entire exam session (03/06 - 31/07 currently) to provide the report

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PASSING THE EXAM - OVERALL

- The final grade will be the sum of the homework extra points (0-2) and the project grade (0-30).
- If you reach a grade > 30, you will obtain «la lode»
- In case you want to improve your results, or you prefer not to work on your individual project, or you can't provide the results before the deadline (31/07/20), we will arrange a classical oral test.
  - ➢ Questions will comprehend the entire program, involving discussion of theoretical concepts as well as the design or analysis of a process control scheme.
  - ➢ The oral test grade criteria will comprehend:
    - ❖ knowledge and understanding of the course content
    - ❖ ability to provide quantitative (not only qualitative) information on the dynamic response and control performance of process systems
    - ❖ ability to discuss the topics in a clear, organic and concise way, and with appropriate use of terminology

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PASSING THE EXAM - RECOMMENDATION

- Take the exam ONCE AND ONLY ONCE. Take advantage of the opportunity to work on a home project.
- Try to work as soon as possible on your project. In case of doubts, you will have time to clarify them.
- If you follow the course actively, you won't have to spend time on basic concepts, working directly on the project assigned.
- It is essential that each student solves the first two homework activities individually. If you work in group or you help someone else, you are damaging your peer, as he/she won't develop the skills required for solving the final project.
- Do not discuss the homework with your friends until all of you have handed over their own homework. If you need help for the solution, write me an email!

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ACKNOWLEDGMENTS

- This course has been structured on the «*Process dynamics and control*» course @ University of Padova, held by prof. Massimiliano Barolo
- He is a top level scientist in process dynamics and a pioneer of learning engagement.
- That's the reason why we decided to contact him in order to offer you a hint of his teaching experience in this course.
- I'll do my best to employ his suggestions and teaching material to provide you a top quality learning experience.

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