Control and Instrumentation of Chemical Processes

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Control and Instrumentation

- Course Information
- Basic concepts and course aims
- Programme
- Activities
- Laboratory
- Methodology
- Marking
## Course Information

<table>
<thead>
<tr>
<th>Type:</th>
<th>Compulsory, 10.5 credits (3 Instrumentation + 7.5 Control)</th>
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<tbody>
<tr>
<td>Year:</td>
<td>4th, annual code 44316</td>
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<tr>
<td>Timetable:</td>
<td>First semester: Thursdays 9 to 11h</td>
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<td></td>
<td>Second semester: Mon., Tues. and Wednesdays 11 to 12h.</td>
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<td>Classroom: ISA Seminar</td>
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<td>Lab. Timetable:</td>
<td>Second semester: Tuesdays from 16 to 18 h, 18 to 20 h.</td>
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<td></td>
<td>Two groups. Systems Engineering and Automatic Control</td>
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<td></td>
<td>Lab. Bottom floor, right hand wing of the Faculty, at the</td>
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<td></td>
<td>end of the corridor.</td>
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<td>Course Faculty:</td>
<td>Cesar de Prada Moraga, Dpt. Systems Engineering and</td>
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<td>Automatic Control (ISA) / Mª Jesus de la Fuente (Spanish)</td>
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<td></td>
<td>Instrumentation topics 1.2 and 1.3 given by M.A. Urueña</td>
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<td>Dpt. of Chemical Eng. In the first semester</td>
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**WEB page:** [www.isa.cie.uva.es/~prada](http://www.isa.cie.uva.es/~prada) + Moodle
Task of a Chemical Eng.

**Design**

Build a process according to some specifications

**Operation**

Manage the process under changing conditions

**Automatic Control**

The process must function autonomously in the desired way
Process control
Manual operation of a process

Observe the level
Compare with desired value
Decide the valve position
Act on the valve
Manual operation of a process

Observe the temperature
Compare with desired value
Decide about the valve position
Act on the valve
Process operation

Open loop or manual operation

Compare
Decide

Act

Changes

Process

Dynamical response

Process responses

Observe
Automatic operation

Substitutes the human operator

Regulator

Changes

Act

Process

Measure

Process responses

Closed loop or automatic operation

Feedback
Automatic operation

Measure the level
Compare with desired value
Decide the valve position
Act on the valve
Automatic operation

Measure the temperature
Compare with desired value
Decide about the valve position
Act on the valve
Components of a control loop

The course will deal with the controllers and the closed loop behaviour
Heat exchanger
Process Dynamics

Liquid level vs. time

Valve opening vs. time
Process control requires:
1 understand the process (closed loop) dynamics
2 maintain some variables close to its desires values in spite of disturbances
In modern process factories, the control of the process is performed from control rooms using distributed control systems (DCS). The course will give also an overview of control technology.
Aims of the course

✓ Acquire basic concepts and a working methodology in:
  ■ Systems Dynamics
  ■ Automatic Control

that allow the student to:
  ■ Understand the dynamic behaviour
  ■ model
  ■ analyse
  ■ Design
  ■ Implement and operate

automatic control systems in the process industry.

✓ Acquire practical experience on instrumentation, tools and computer systems used in process control.
Abilities the student should acquire

- Develop mathematical models for dynamic processes.
- Obtain process dynamics from step response data.
- Familiarity with block diagrams and process and instrumentation diagrams.
- Analyze process stability and dynamic responses
- Familiarize with PID feedback controllers and tuning methods.
- Design control structures for a process (feedforward control, cascade control, etc.)
- Awareness of multivariable process interactions
- Familiarize with process control technology
PSE Process Systems Engineering

- The course belong to the field of Process Systems Engineering (PSE)
- **PSE** is the body of knowledge in chemical engineering that deals with the systematic modelling and development of tools and solution methods for synthesis, analysis and evaluation of Process Design, Process Control and Process Operation and Optimization
- PSE is a field where multiple disciplines cooperate in order to find useful solutions: from chemical, control, electrical, etc. engineering, to applied mathematics, basic sciences (biology, physics, etc.) and computer science.
Systems Methodology

- Analyse the process
- Formulate the problem in mathematical terms
- Take into account its dynamics and interactions
- Analyse and solve the problem with the appropriate methods and tools
- Interpret the results in terms of the reality
- Apply the solutions
Programme

1 Introduction
   - Instrumentation
   - Controllers
   - Programmable logic controllers

2 Dynamical models

3 Linear systems analysis

4 Design and implementation of process control systems
Bibliography

Control e Instrumentación de procesos químicos, Ollero, Fdez.-Camacho, Edt. Sintesis, 1997

Ingenieria de control moderna, Ogata, Edt. Prentice Hall Inter. 4ª edc, 2003


Automatic Tunning of PID Regulators, Astrom, Hagglund, Edt. ISA, 1995

Tuning of industrial control systems, A. B. Corripio., Edt. ISA, 1990


Control Avanzado de Procesos, José Acedo Sanchez, Edt. Diaz de Santos 2002

Control systems Engineering, N.S. Nise, 2ª edic. Addison Wesley, 1995


Books
Lecture notes

- The slides of the course in PowerPoint can be found in:
  - www.isa.cie.uva.es/~prada
  - Lab work
  - Previous exams
  - prada@autom.uva.es
  - Also in Moodle
The registered e-mails will be used in all communications with the students.
Laboratory

Aim: Learn by doing

☑ Practice the theory
☑ Familiarize the student with the tools and control technologies
☑ Two types of processes:

• Simulated processes
• Lab plants with industrial instrumentation and computer control systems
Laboratory

Topics:
1. Lab plants, Instrumentation, Simulation environment (CStation), PLCs, Real time control software (JavaRegula)
2. Process Modelling and Identification (EcosimPro, Cstation)
3. Analysis of dynamical systems (Matlab, Simulink)
4. PID controllers and control structures (JavaRegula, Cstation, EcosimPro)

Four compulsory reports (one per group (3 student max.)):  
1. Logic control PLC. Report due on February
3. System Analysis. Report due on April
4. Control design. Report due on May

Oral presentations of selected groups
Groups can be organized by the students’ representatives
Control room Simulator

- Control room of a sugar factory
- Developed in the CTA by ISA
- Two groups per day
- Starting April the 16th
Visits to industries

**ACOR** Olmedo factory (Valladolid)
Control rooms and process instrumentation
December 2012

**Petronor**, Muskiz petrol refinery (Vizcaya)
Process and control rooms / Advanced control systems
9th May 2013 (Registration until 26th April)

In cooperation with the ISA (International Society of Automation) student section, UVA

"Control Predictivo Multivariable"
Rafael Gonzalez, Petronor, 9th May 2013

“Hacia la excelencia en Automatización”
Raquel Mateos, Honeywell, Presidenta de ISA-España, 8 Marzo

In cooperation with ISA (International Society of Automation) student section, UVA
CEA-ISA contest

Organized jointly by ISA and CEA with the aim of providing challenging problems to students interested in control

http://www.ceautomatica.es/og/control-inteligente/concurso-en-ingenieria-de-control-2013-0

http://youtu.be/-7yW2yhJ3LQ
ISA European Student Competition (ESPC’12). The papers can deal with any topic related to instrumentation, control, systems, automation, etc. They will be published in the EuroXchange Journal. 4-6 pages. Closing date: 25th March
Marking

- The Instrumentation topics (1.2 y 1.3) given by Dr. Urueña Dpt. Of Chemical Eng. in the first semester have an independent exam and will weight 25 % of the final mark.
- The control topics will weight 75% of the final mark.
- In order to pass the course, it is necessary to pass both parts, or compensate the marks, assuming that at least 4 points have been obtained on each one.
- The marks are valid during the whole academic year.
Marking 2nd semester (Control)

- Lab reports (30%) Assuming that at least 4 points have been obtained in the exam.
- Lab contest to the best presentation. Prize: 2 points in the exam.
- Exam (70%)
  - EuroXchange Journal (ISA)
  - Prize CEA- ISA estudiantes
  - Prize Empresarios Agrupados
  - Prize Omron
  - ....
Marking 2nd semester (Control)

Exam: 5th June 2013 / 16th July 2013

Exam:
- 2 problems (3 h., open book)
- a set of questions (theory + exercises) (1 h. closed book)

Marking: 60 % problems and 40 % questions. Minimum mark for compensation: 4

Examples of typical exams can be found in the web page.
Doubts / Questions, etc.

- I shall be available in my room at the Dpt. of Systems Engineering and Automatic Control. Ground floor, right wing of the Faculty
- E-mail:
  - prada@autom.uva.es
  - maria@autom.uva.es
Dissertation projects

- Several projects are available for those students wishing to develop his final degree project with the ISA department. They cover applications in the petrochemical and sugar industry, pilot plant development, CERN, energy, etc.


- The doors are open for those students wishing to collaborate in current research projects develop with ISA partners: Repsol-Petronor, CERN, HYCON2, SYSGAS, EA, CTA etc. Topics cover modelling, simulation, advanced control, process optimization, etc.

- Other projects can be developed with pilot plants in the lab.

- Research work: Also, a set of projects is offered to those students that wish to develop a research project (1 - 15 credits).
Complementary courses

- They will give you an specialization in the Process Systems Engineering field
- Control por computador
- Informática aplicada a la Ingeniería Química
- Sistemas de supervisión de procesos