Control and Instrumentation of Chemical Processes

Prof. Cesar de Prada

Dpt. of Systems Engineering and Automatic Control

UVA

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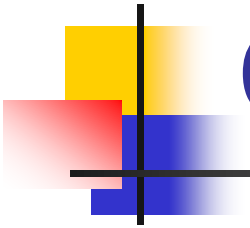


Control and Instrumentation

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

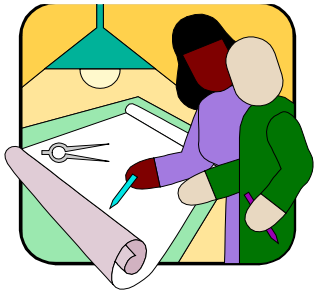
Course Information

Type:	Compulsory, 10.5 credits (3 Instrumentation+ 7.5 Control)
Year:	4th, annual code 44316
Timetable:	First semester: Thursdays 9 to 11h Second semester: Mon., Tues. and Wednesdays 11 to 12h. Classroom : ISA Seminar
Lab. Timetable:	Second semester: Tuesdays from 16 to 18 h, 18 to 20 h. Two groups. Systems Engineering and Automatic Control Lab. Bottom floor, right hand wing of the Faculty, at the end of the corridor.
Course Faculty:	Cesar de Prada Moraga, Dpt. Systems Engineering and Automatic Control (ISA) / Mª Jesus de la Fuente (Spanish) Instrumentation topics 1.2 and 1.3 given by.M.A.Urueña Dpt. of Chemical Eng. In the first semester

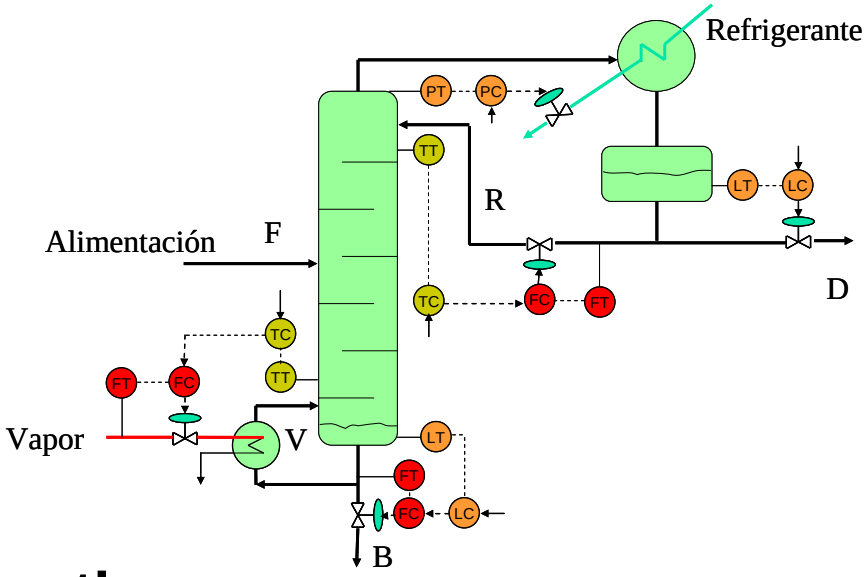
WEB page: www.isa.cie.uva.es/~prada + Moodle

Task of a Chemical Eng.

Design



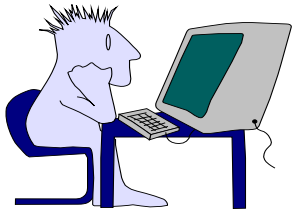
Build a process according to some specifications



Operation

Manage the process under changing conditions

Automatic Control

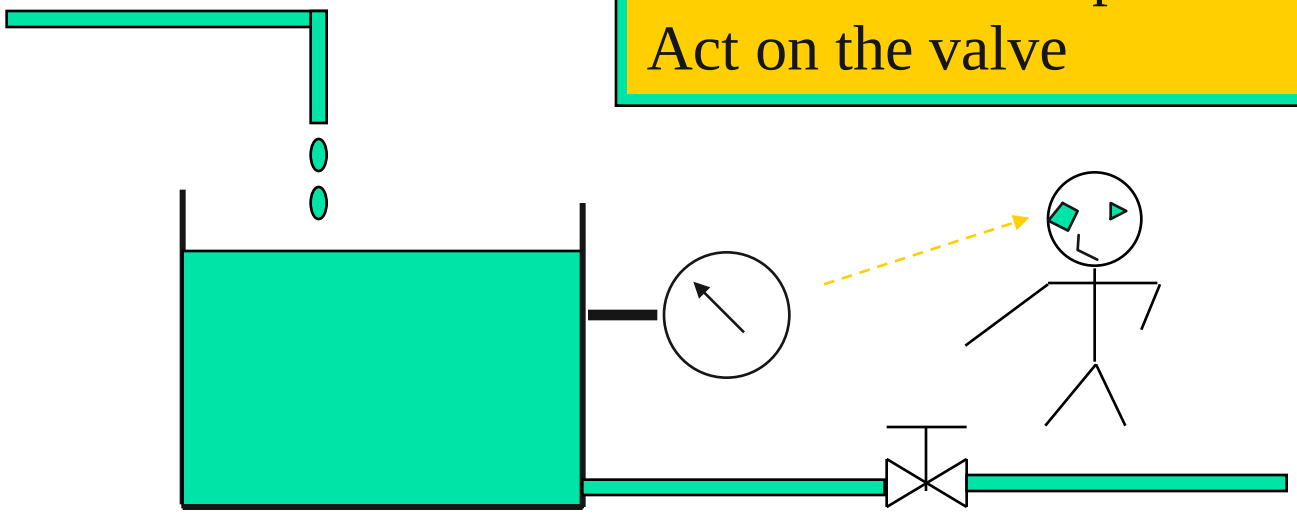


The process must function autonomously in the desired way

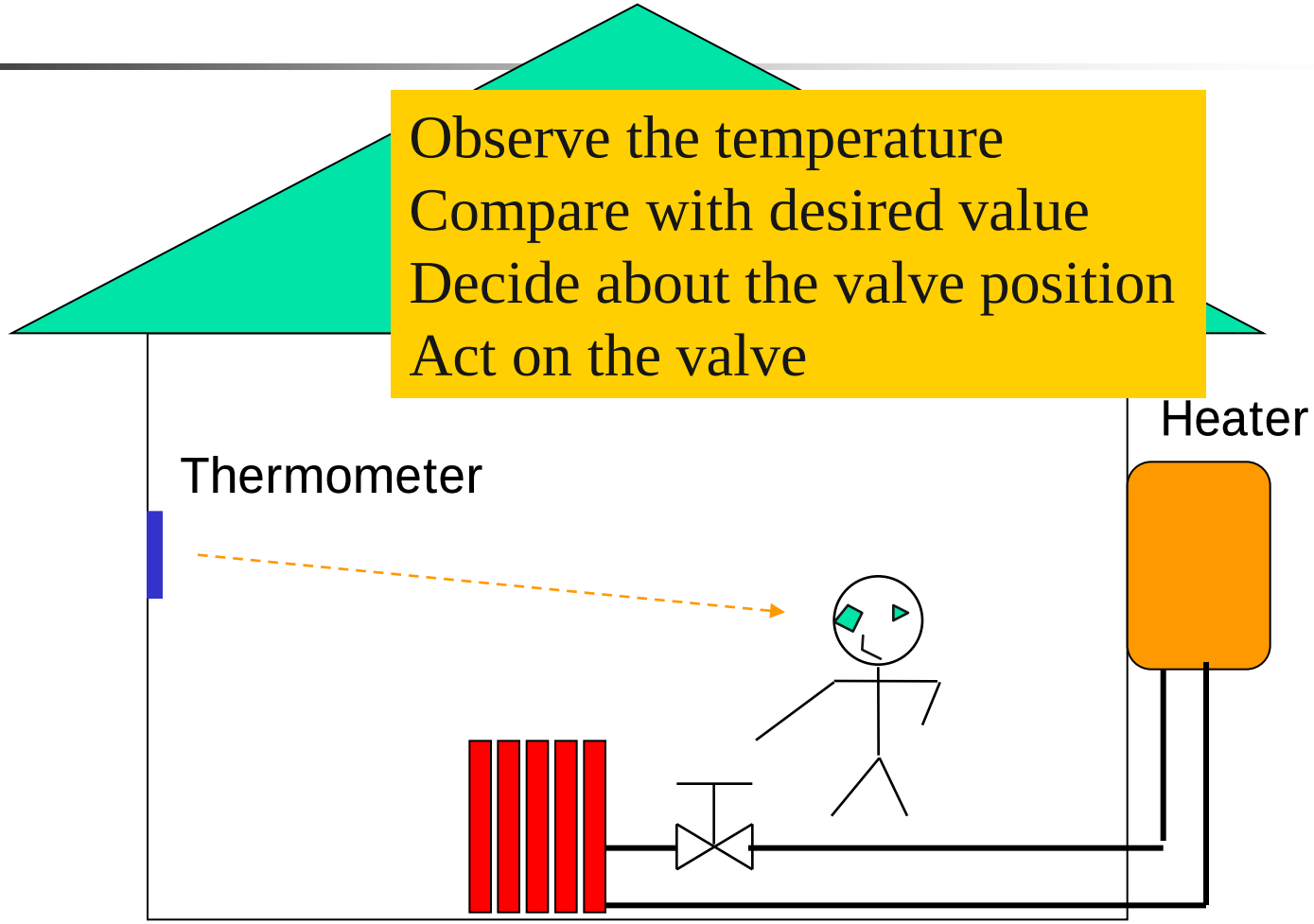
Process control

Manual operation of a process

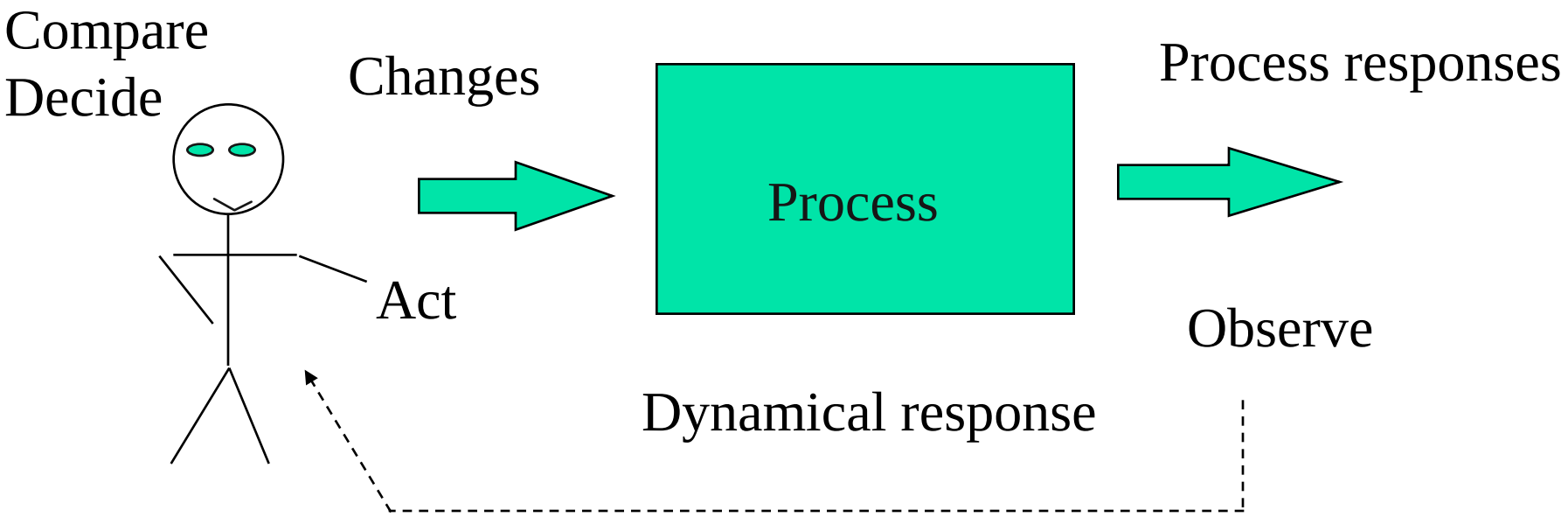
Observe the level
Compare with desired value
Decide the valve position
Act on the valve



Manual operation of a process

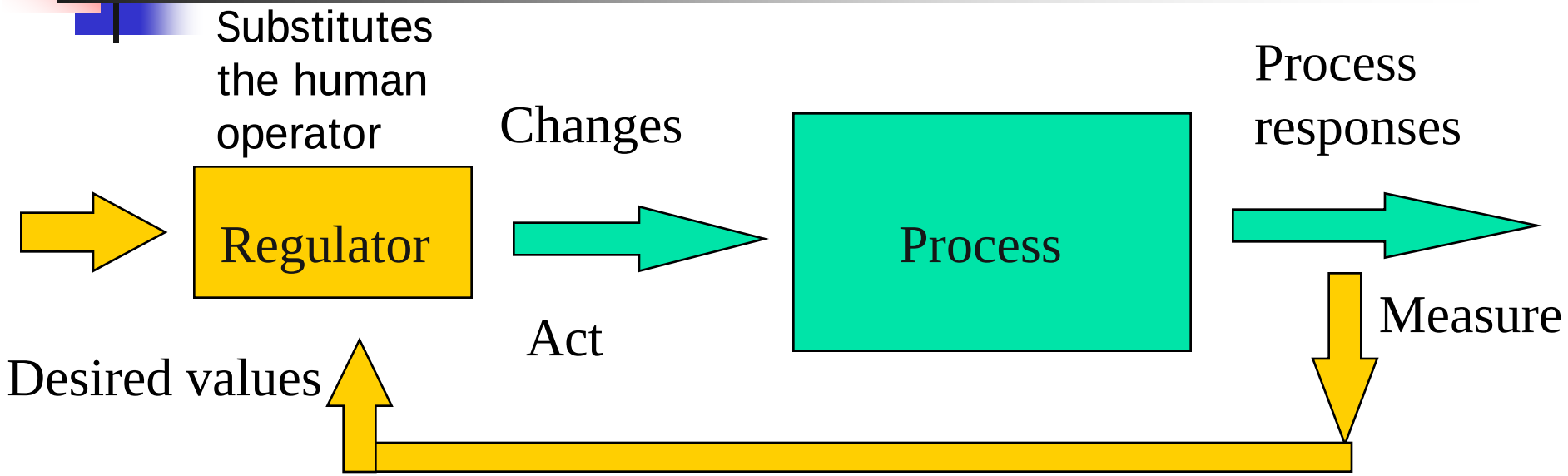


Process operation



Open loop or manual operation

Automatic operation

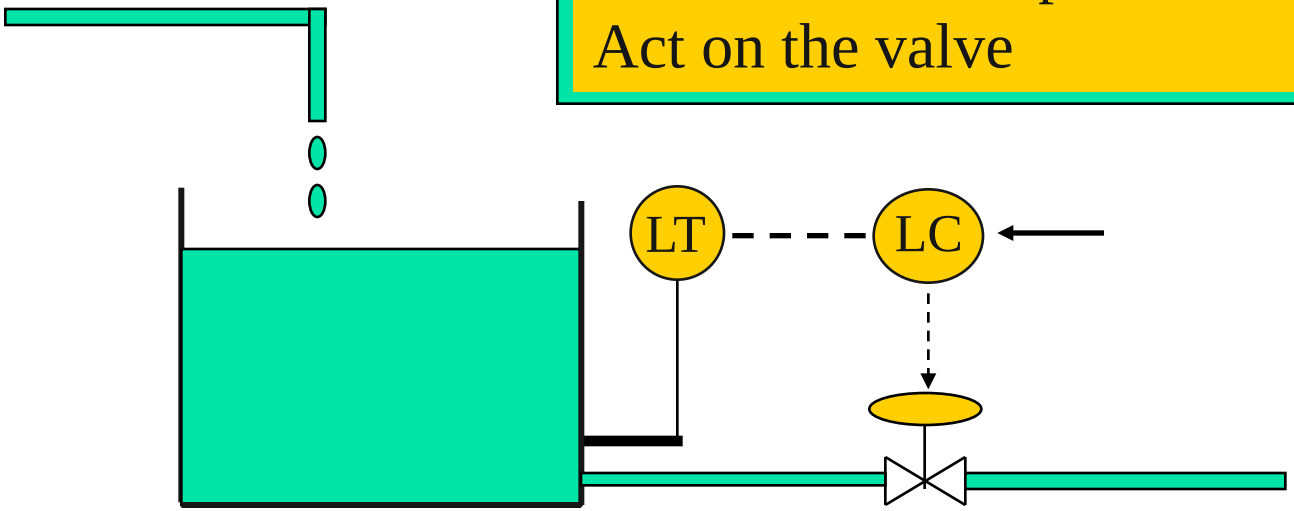


Closed loop or automatic operation

Feedback

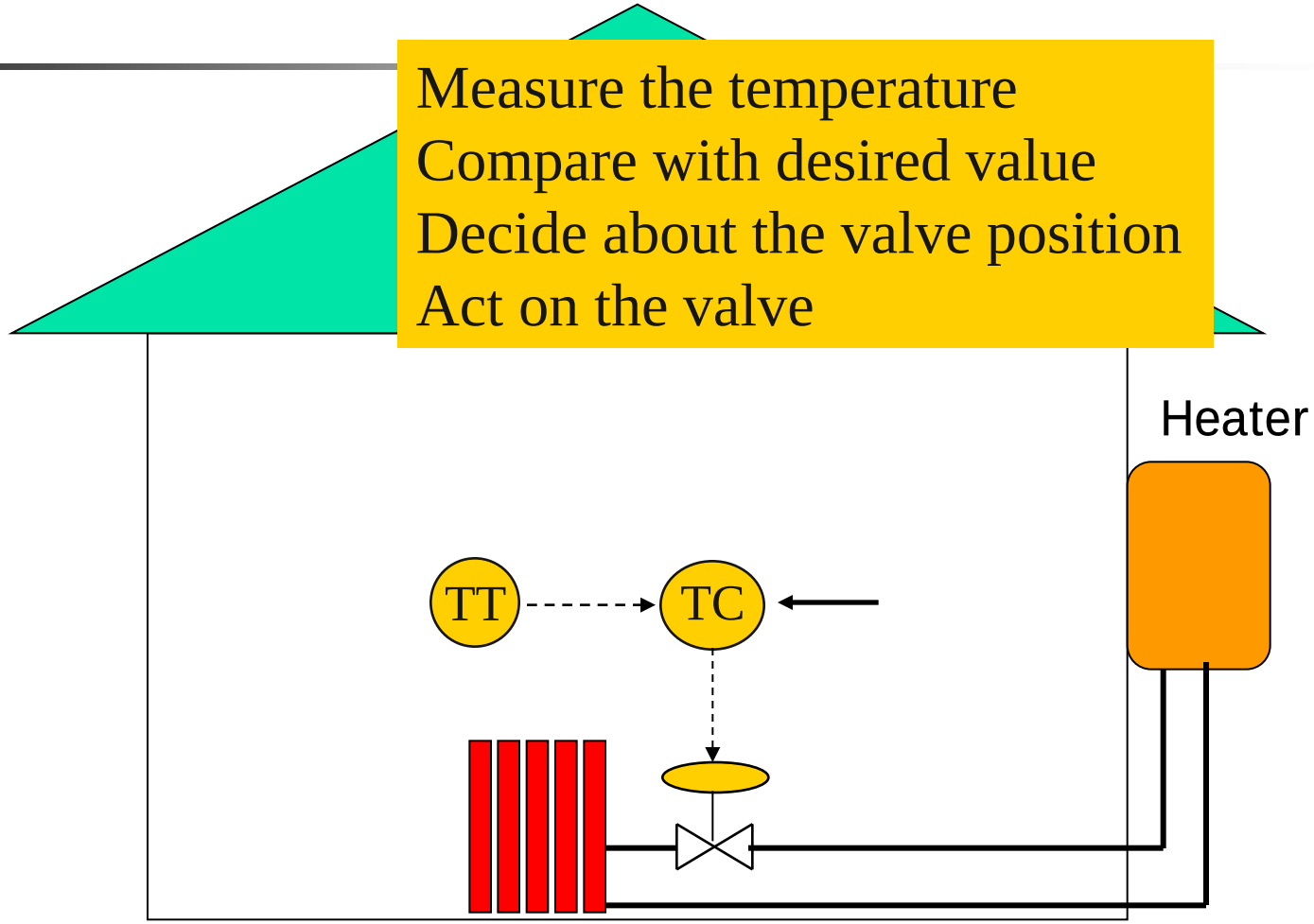
Automatic operation

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

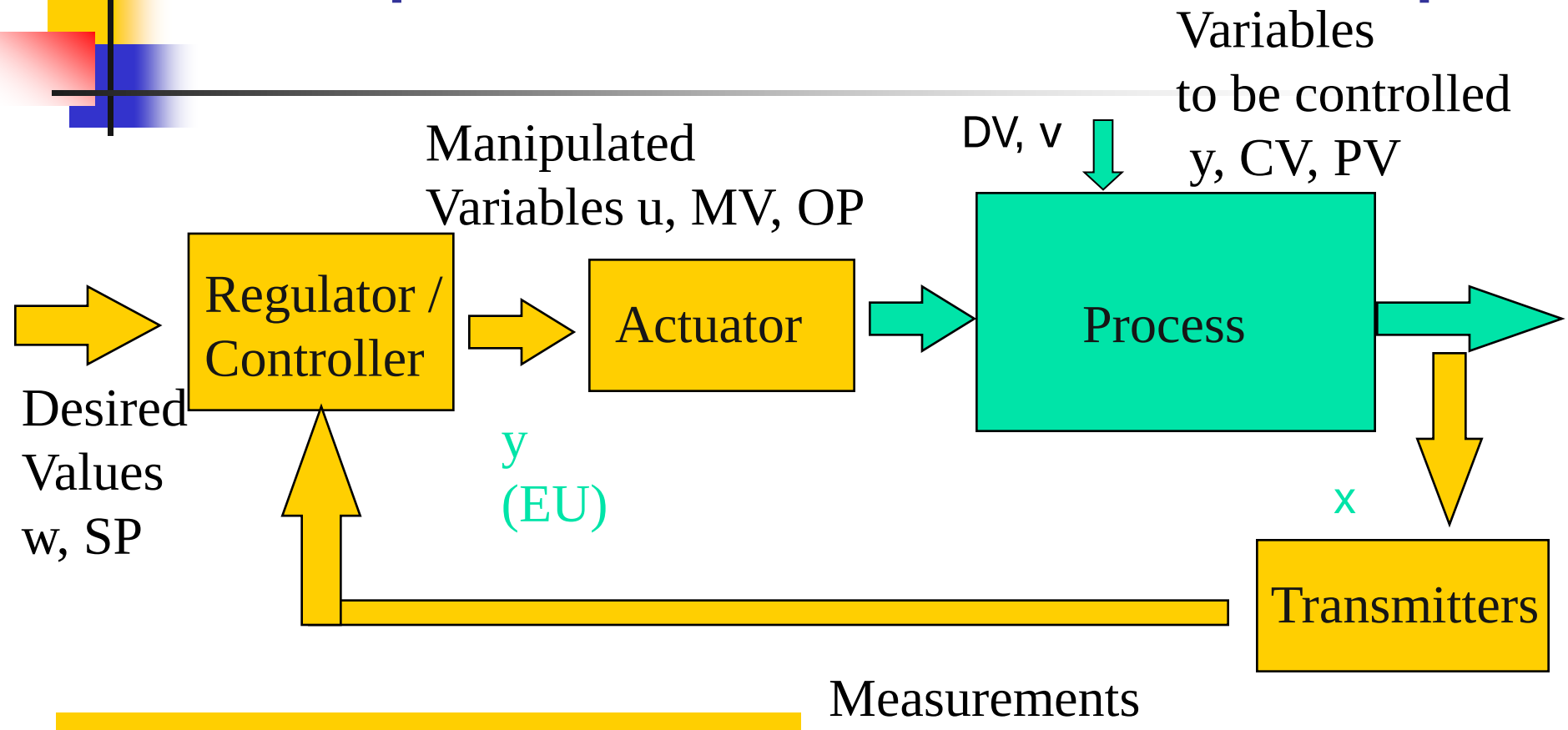


Automatic operation

Measure the temperature
Compare with desired value
Decide about the valve position
Act on the valve

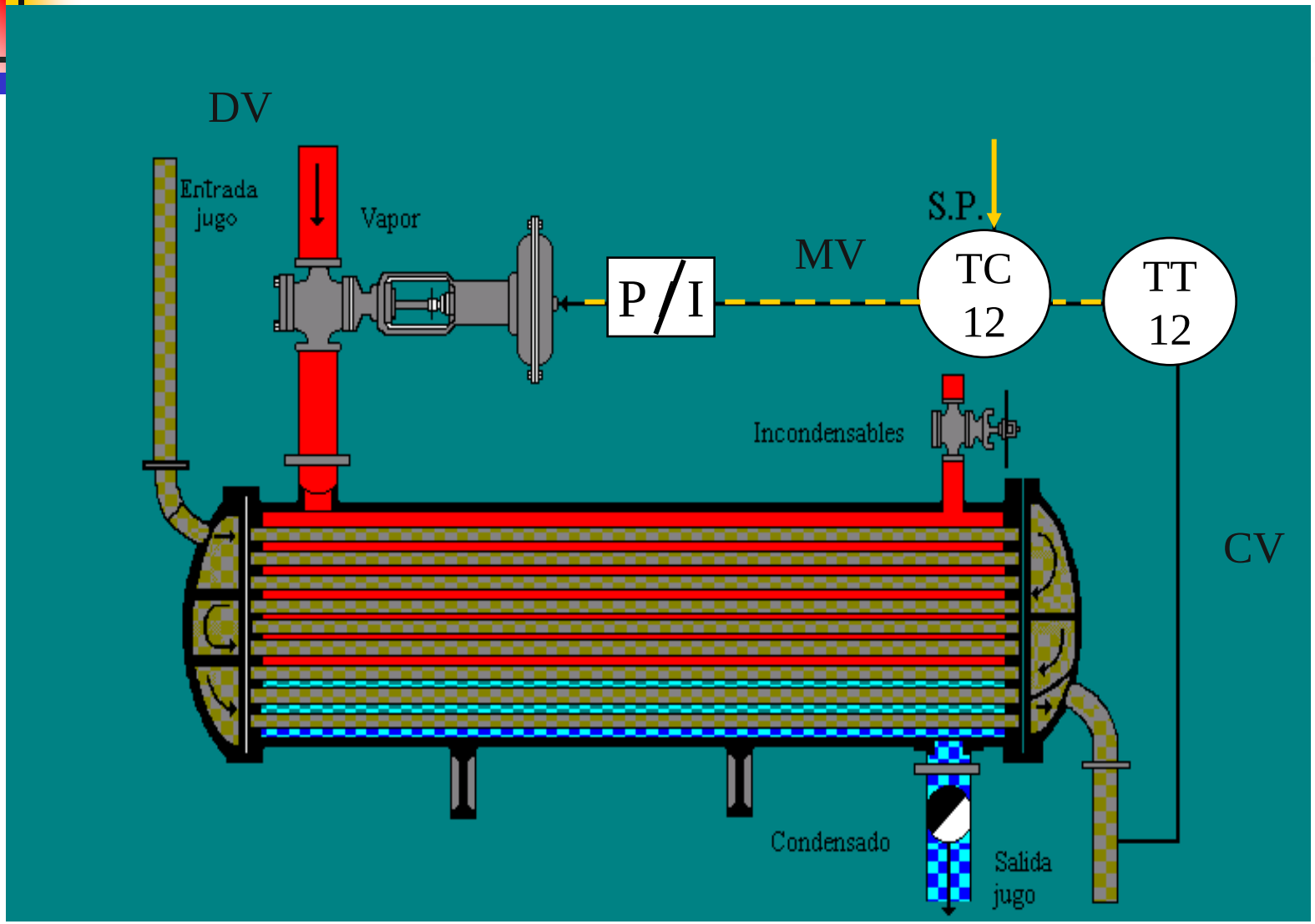


Components of a control loop

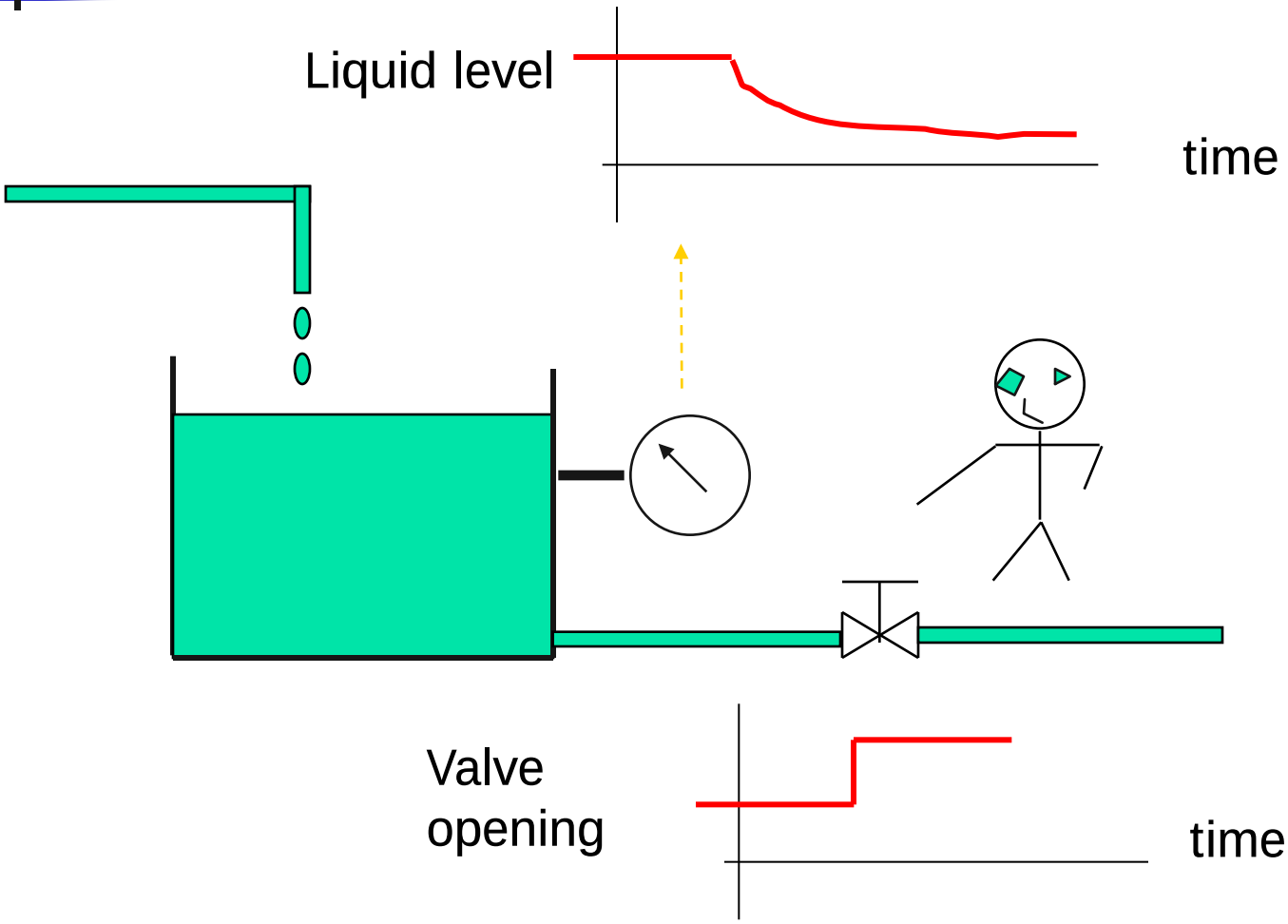


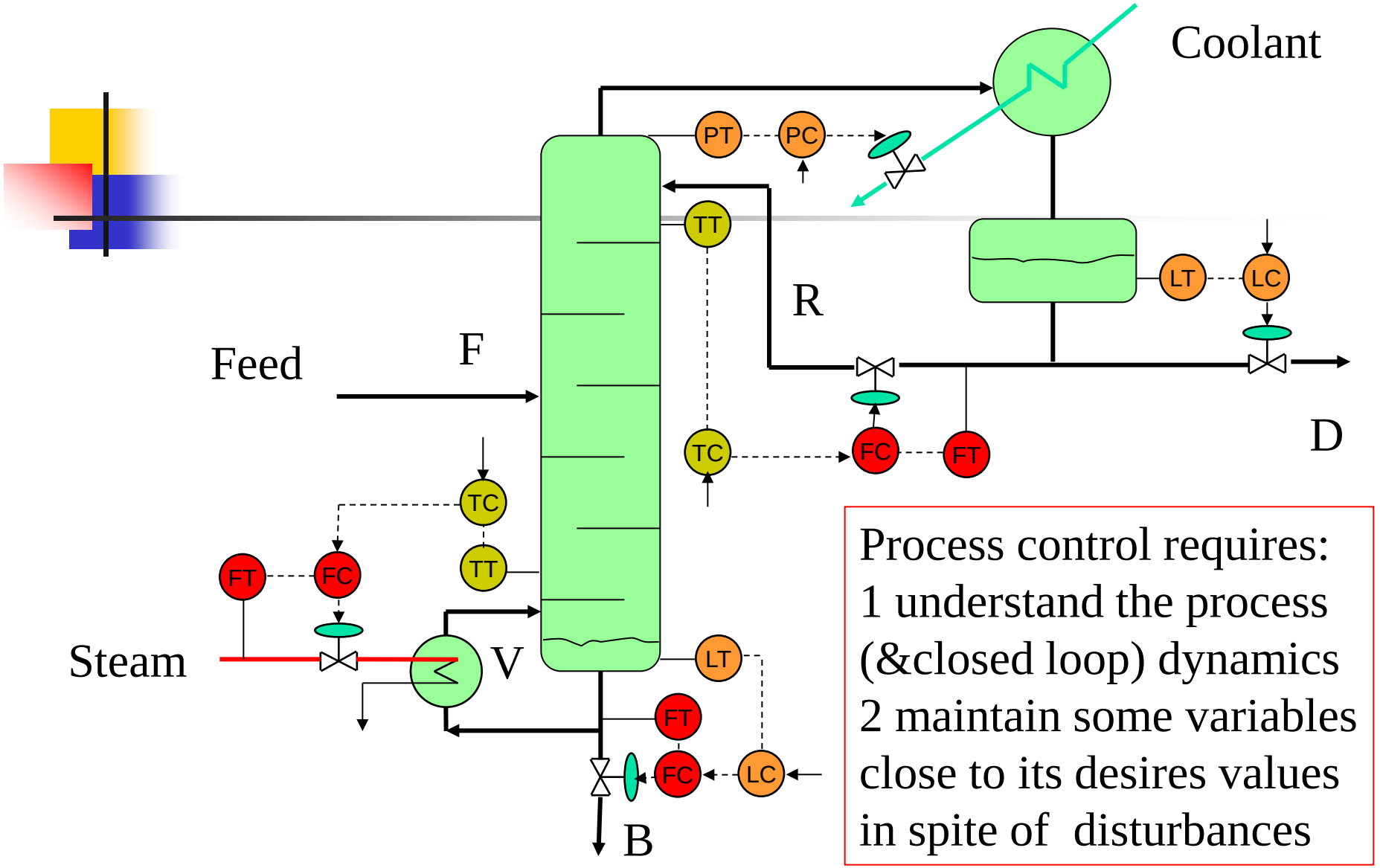
The course will deal with the controllers and the closed loop behaviour

Heat exchanger



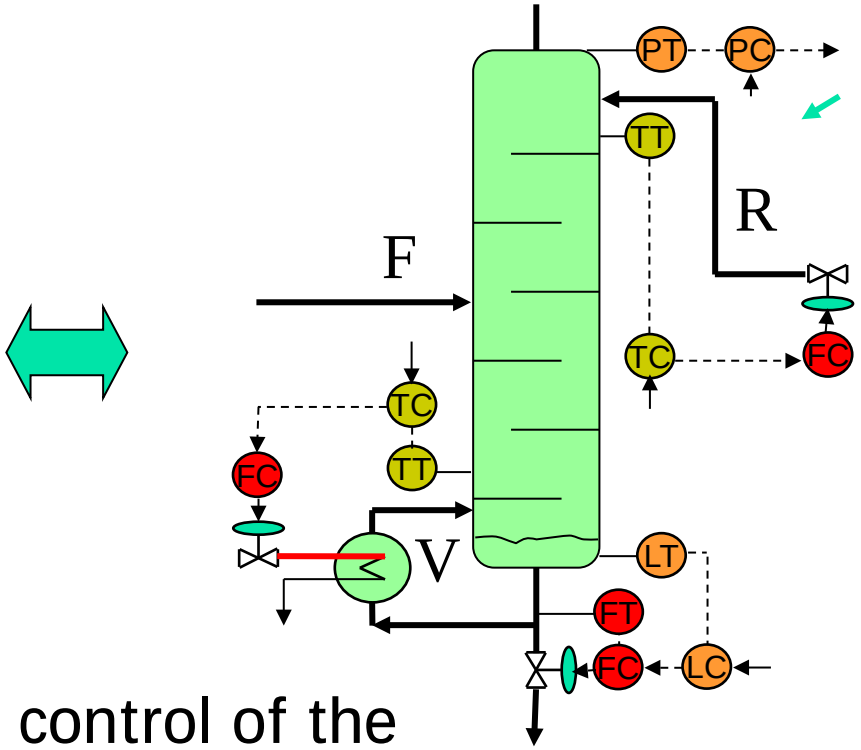
Process Dynamics





Process control requires:
1 understand the process (&closed loop) dynamics
2 maintain some variables close to its desires values in spite of disturbances

Control and Instrumentation



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.

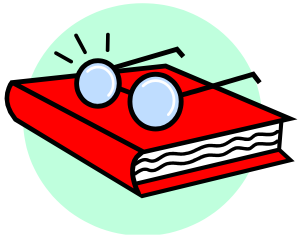
Systems Methodology

- 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

Process Dynamics, Modeling and Control, B.A. Ogunnaike, W.H. Ray, Oxford Univ. Press, 1994

Principles and practice of Automatic process control ,Smith,Corripio, Edt. John Wiley, 2006

Essentials of process control,W.L. Luyben, M.L. Luyben, Edt. Mc Graw-Hill, 1997

Process modeling, simulation and control for chemical eng., Luyben, Edt. McGraw Hill, 1990

Process Dynamics, Modelling, Analysis and simulation, B. Wayne Bequette, Edt. Prentice Hall, 1998

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

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

Manual de instrumentación y control de Procesos, Edt. Alción, 1998

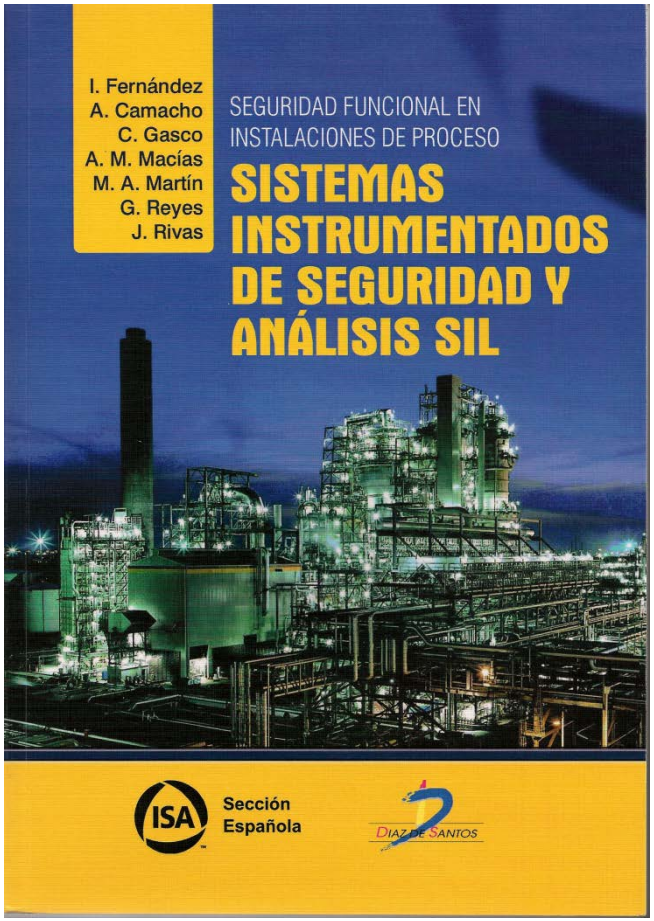
Control Avanzado de Procesos, José Acedo Sanchez, Edt. Diaz de Santos 2002

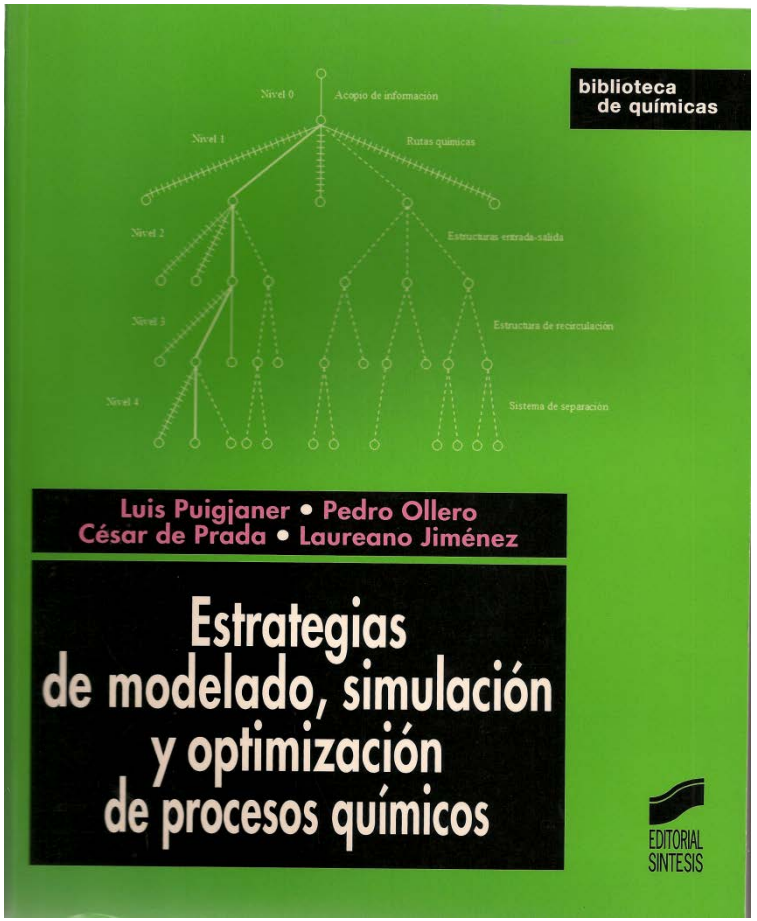
Control systems Engineering, N.S. Nise, 2ª edic. Addison Wesley, 1995

Process Dynamics and Control, D.E. Seborg, T.F. Edgar, D.A. Mellichamp, J. Willey, 1989

The Condensed Handbook of Measurement and Control, N.E. Battikh, Edt. ISA, 2nd Edition, 2003

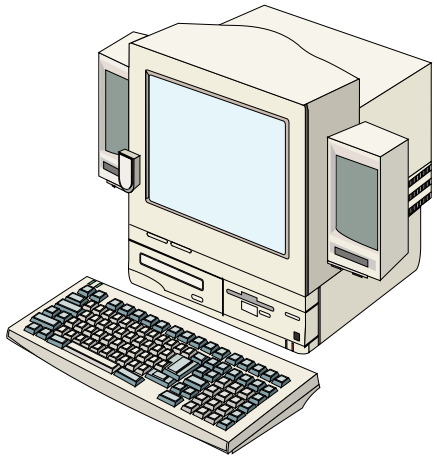
Books


I. Fernández
A. Camacho
C. Gasco
A. M. Macías
M. A. Martín
G. Reyes
J. Rivas
SEGURIDAD FUNCIONAL EN INSTALACIONES DE PROCESO
SISTEMAS INSTRUMENTADOS DE SEGURIDAD Y ANÁLISIS SIL
ISA
Sección Española
DIAZ DE SANTOS


biblioteca de químicas
Nivel 0
Acopio de información
Nivel 1
Rutas químicas
Nivel 2
Estructuras entrada-salida
Nivel 3
Estructura de recirculación
Nivel 4
Sistema de separación
Luis Puigjaner • Pedro Ollero
César de Prada • Laureano Jiménez
Estrategias de modelado, simulación y optimización de procesos químicos
EDITORIAL SINTESIS

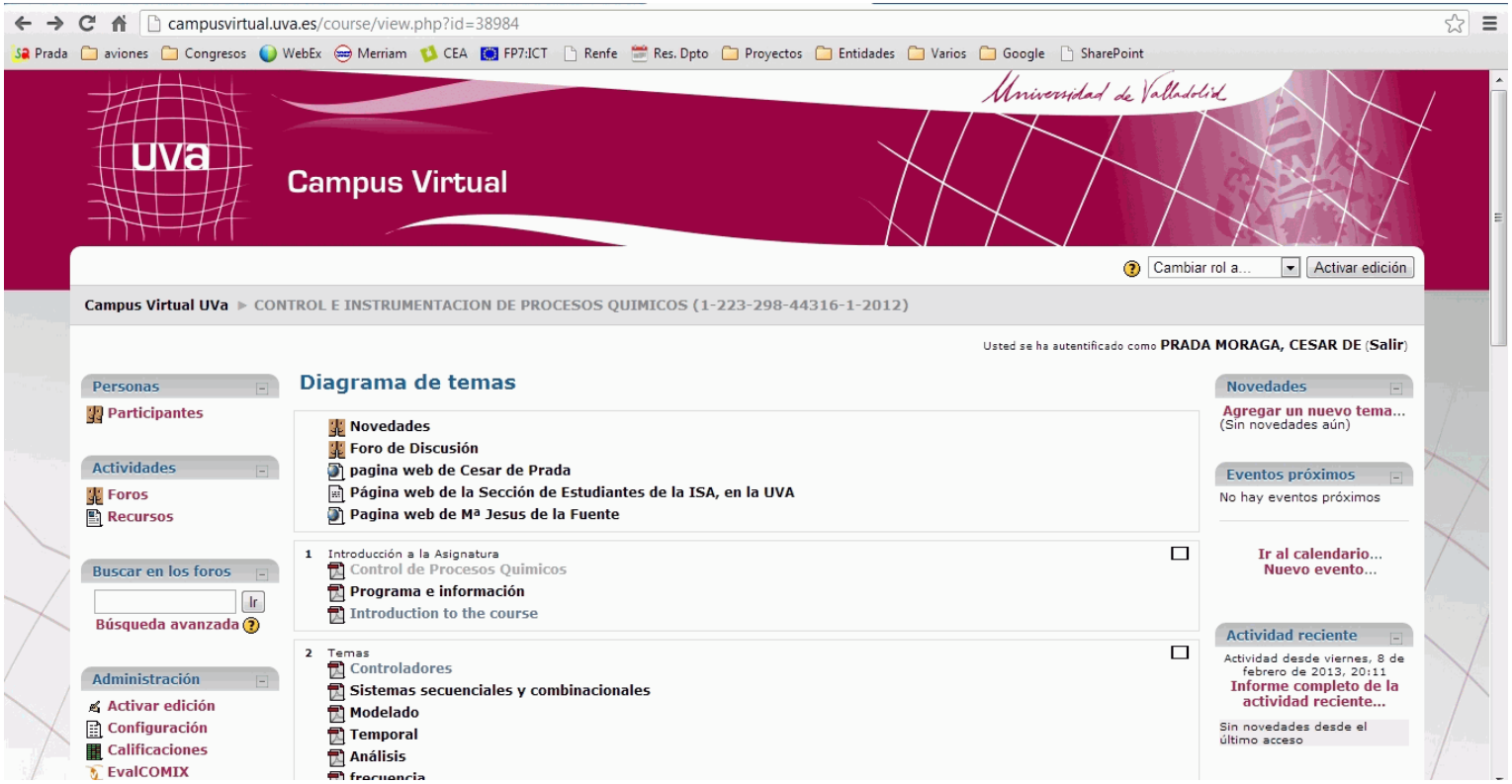
Lecture notes

- 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



Moodle

http://campusvirtual.uva.es/



The registered e-mails will be used in all communications with the students

Laboratory

Forum, discussion groups, Internet

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
2. Process modelling. Report due on March
3. System Analysis. Report due on April
4. Control design. Report due on May

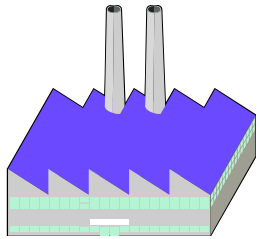
Oral presentations of selected groups

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
http://www.isa.org/ http://www.isa-spain.org

Conferences

"Control Predictivo Multivariable"
Rafael Gonzalez, Petronor, 9nd 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 papers

ISA european student competition to the best student paper. (ESPC'12). The papers can deal with any topic related to instrumentation, control, systems, automation, etc.
They will be publish 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.
- Topics in: http://www.isa.cie.uva.es/~prada/
- 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