Introduction to Computer Control Systems

Responsible teacher: Kristiaan Pelckmans (kp@it.uu.se)

Credits: 5 hp

Course code: 1RT485

Period 2 (Week 43-50)

Course plan

- **Teachers and activity**
  - Kristiaan Pelckmans   - Lectures
  - Jesus Zambrano   - Problem solving sessions
  - Ruben Cobo   - Labs

- **Structure**
  - 10 lectures (20h)
  - 10 problem solving sessions (20h)
  - 2 computer labs (4h)
  - 3 process labs (12h)

- 5hp$\rightarrow$400/3 h $\approx$ 133h. ((400/3h-56h) $\approx$ 77h of self-study, readings and homework assigments)

General information

- Homepage. Please, visit it frequently!
  http://www.it.uu.se/edu/course/homepage/regsysintro/ht11

- Textbook
  - Torkel Glad and Lennart Ljung: Control Theory - Multivariable and Nonlinear Methods, Taylor and Francis, 2000.

- Examination
  - Written examination on Wednesday, December 14th 2013.
  - Passed laboratory is also required.

Introduction to Computer Control Systems

- ## What does this course offer to you?

  - The course covers theoretical and practical topics of control systems
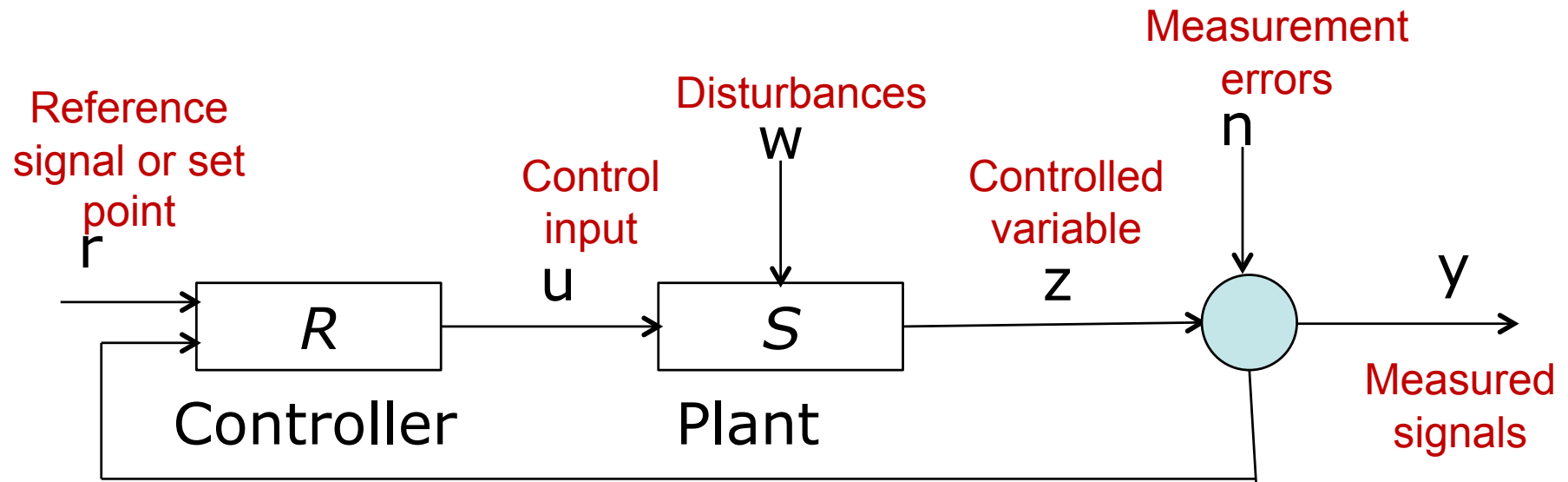
- ## What are the skills that you can develop?

  - The course prepares you for analysis, design and implementation of control systems

- ## How will we do that?

  - Participatory lectures, problem solving sessions, process and computer labs (LEGO NXT, Matlab)

- ## Written exam + compulsary labs
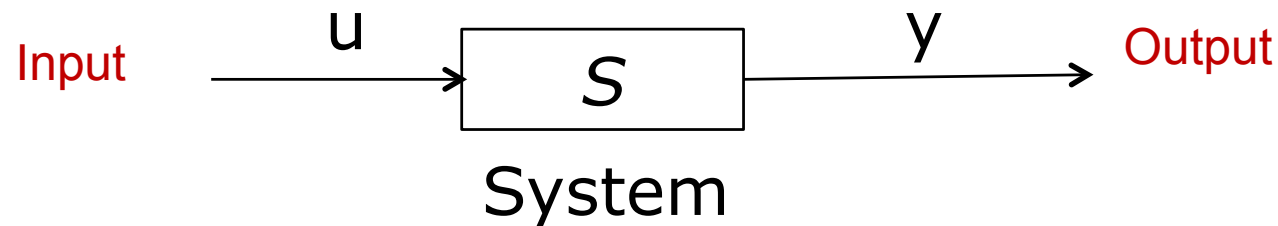
Lecture 1: Introduction and basic notions. The control problem

- The feedback concept

The system (I)

- A system is defined by its inputs and outputs
  - System input – a signal fed into the system
  - System output – a measurable signal that is produced by the system

Input $\xrightarrow{\quad u \quad}$ $\boxed{S}$ $\xrightarrow{\quad y \quad}$ Output

System

- A system is single input - single output (SISO system) if it has one input and one output, otherwise is a multivariable system (MIMO system)

The system (II)

- A system is <u>causal</u> if y(t) only depends on current and previous values of u(t), otherwise is a non-causal system

- A system is static if y(t) at $t=t_1$ depends only in u(t) at $t=t_1$ (no memory), otherwise is a <u>dynamic</u> system (system with memory)

The system (III)

- A system is in <u>discrete-time</u> if the inputs and outputs are defined only for a number of time points $(t=t_0+\Delta t_0, t_0+2\Delta t_0, t_0+3\Delta t_0, \ldots)$, otherwise is a <u>continuous-time</u> system

- A system is <u>time invariant</u> if it does not depend on absolute time, otherwise is a time varying system

- A system is <u>linear</u> if it satisfies the principle of superposition and homogeneity, otherwise it is a <u>nonlinear</u> system
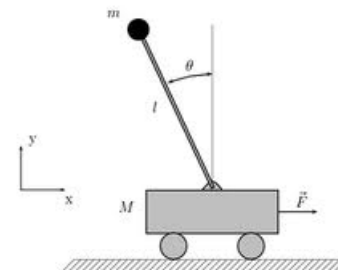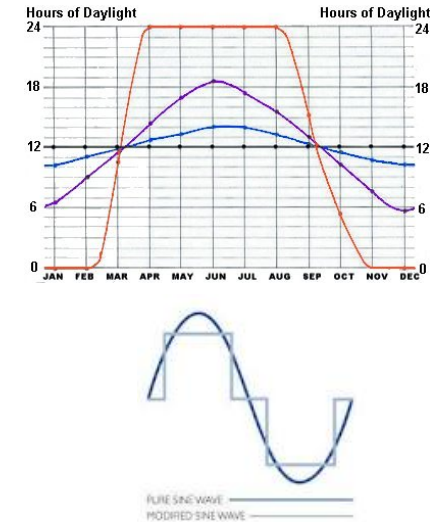
Stress!

System modelling

- A model is a mathematical representation of a system

- Models are always approximations

- Not all natural phenomena have a mathematical description

- A model can be created before the actual system is constructed

- Only certain (relevant) system properties are described

"essentially, all models
are wrong, but some
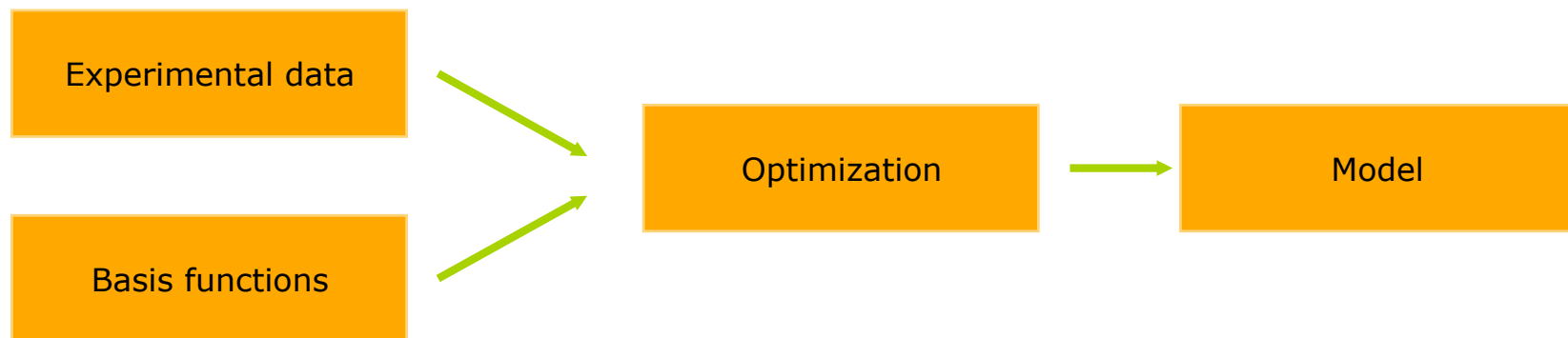are useful"
George E.P. Box

Mathematical modeling

- Model derivation
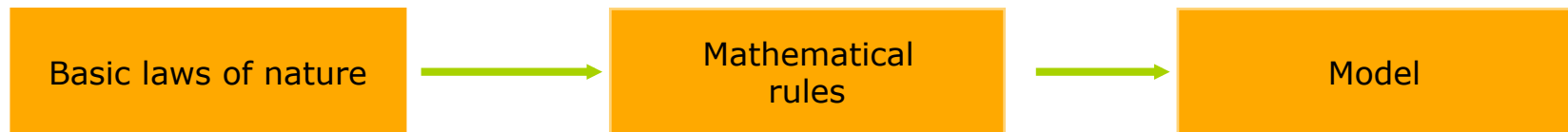
- System identification (model fitting through optimization)

The use of mathematical modeling

Mathematical modeling is a fundamental scientific approach and utilized for **analysis** and **synthesis** of systems in nature, technology and society.

Analysis

- Prediction and forecast (economy, environment)
- Diagnosis

Synthesis

- Design and engineering of processes and systems
- Optimization of systems and processes
- Control
- Process monitoring
- Estimation of inaccessible for measurement quantities ("soft sensors", "sensor fusion")

Our system: LEGO car

- Input signals: motor voltage

- Output signal: car position

- Disturbance: track conditions

To do

- ## For next lecture

  - Read Chapter 2 of the guide book

- ## For lecture 4

  - Search the web and pick an article about a control system. Try to identify the control system, particularly:
    - The controlled variable
    - The control input
    - The reference signal