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
  - – Problem solving sessions
  - Liang Dai – Labs
- Structure
  - 10 lectures (20h)
  - 10 problem solving sessions (20h)
  - 2 computer labs (4h)
  - 3 process labs (12h)
- 5hp→400/3 h ≈ 133h. ((400/3h-56h) ≈ 77h of self-study, readings and homework assigments)

General information

- Homepage. Please, visit it frequently!

  http://www.it.uu.se/edu/course/homepage/regsysintro/ht12

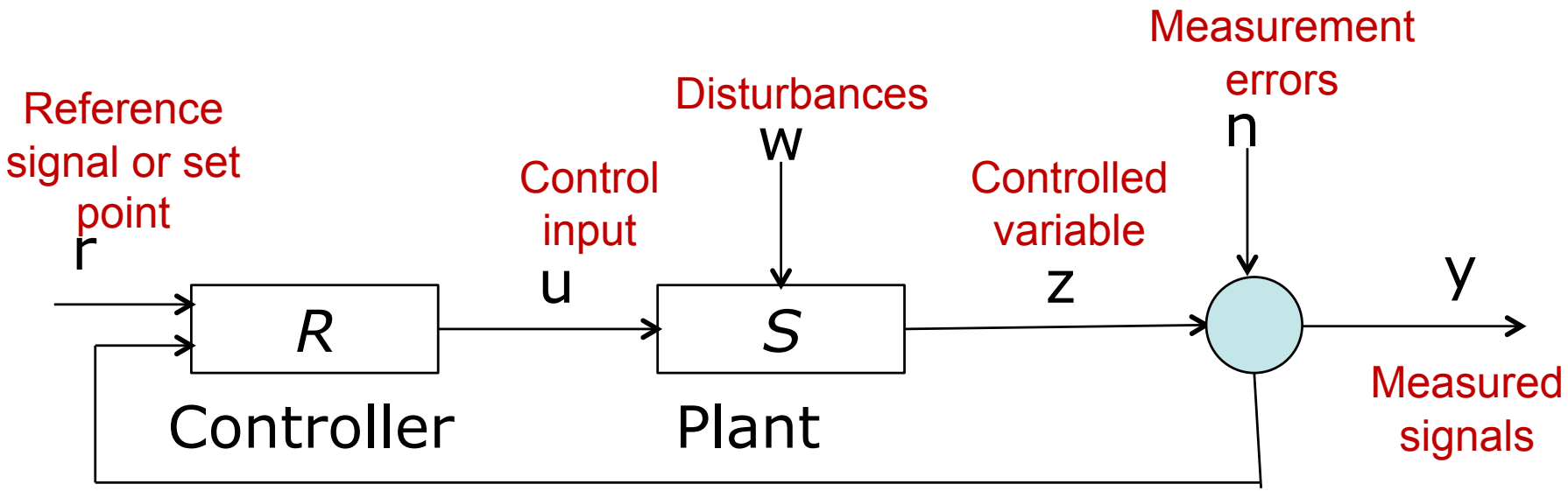
- Textbook
  - Torkel Glad and Lennart Ljung: Control Theory - Multivariable and Nonlinear Methods, Taylor and Francis, 2000.
- Examination
  - Written examination on Wednesday, December 17th 2012.
  - Passed laboratory course is also required.

Introduction to Computer Control Systems

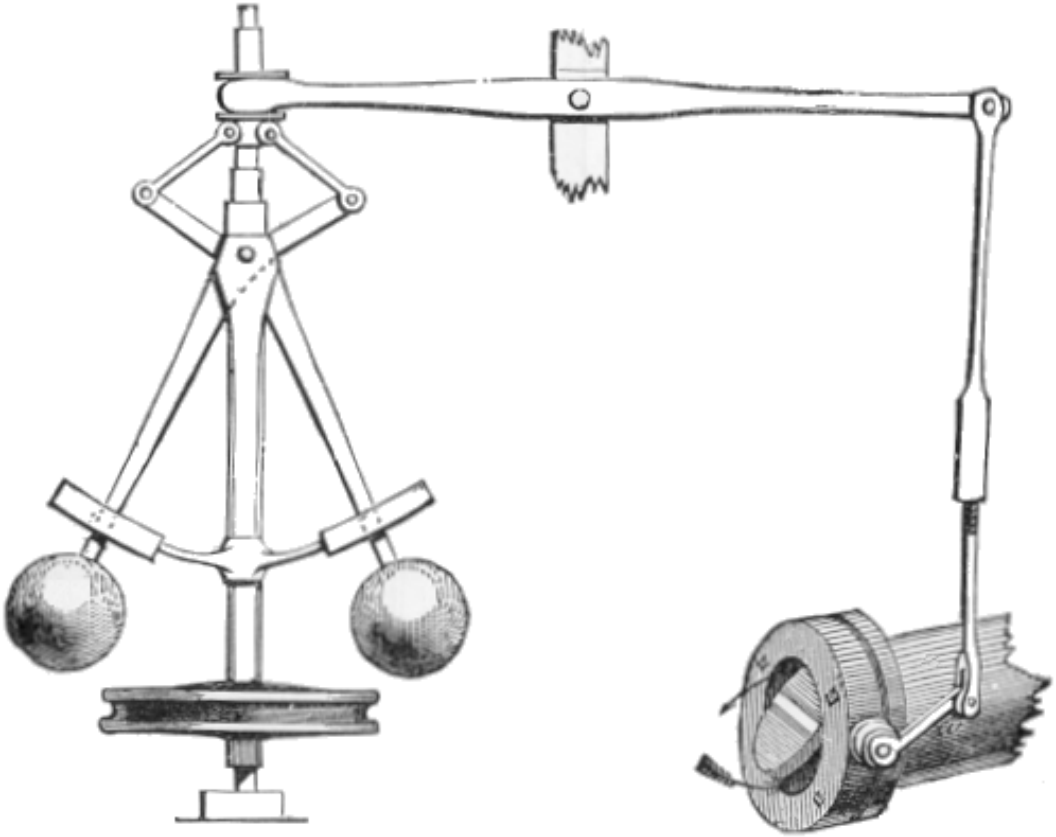
- What does this course offer to you?
  - The course covers theoretical and practical topics of control systems

- 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 + compulsory labs

Lecture 1: Introduction and basic notions. The control problem



- The feedback concept

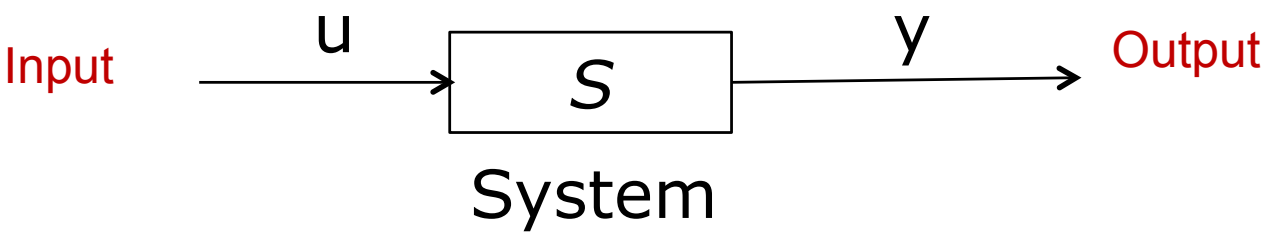


What:

1. Reference r
2. Input System u
3. Controlled var. z
4. Meas.error n
5. Measured Output y
6. Disturbance w
7. Feedback

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



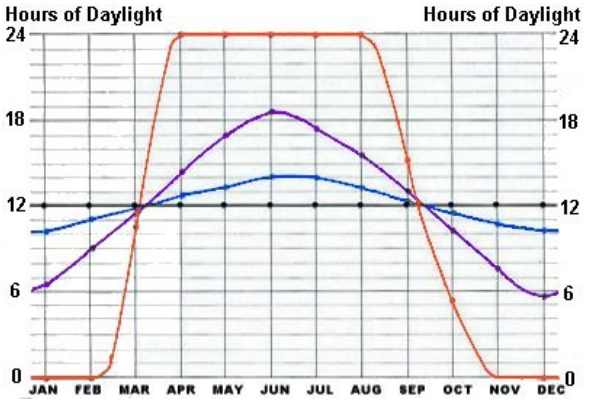
- A system is single input - single output (SISO system) if it has one input and one output, otherwise is a multivariable system (MIMO system)

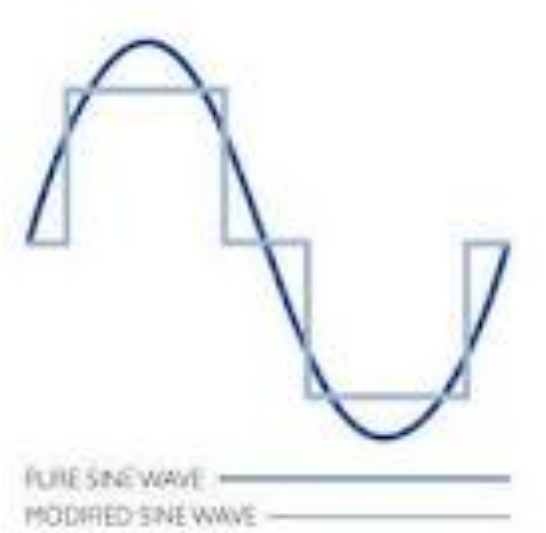
The system (II)

- A system is causal 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 dynamic system (system with memory)

The system (III)

- A system is in discrete-time if the inputs and outputs are defined only for a number of time points ($t=t_0+\Delta t_0$, $t_0+2\Delta t_0$, $t_0+3\Delta t_0$, ...) , otherwise is a continuous-time system
- A system is time invariant if it does not depend on absolute time, otherwise is a time varying system
- A system is linear if it satisfies the principle of superposition and homogeneity, otherwise it is a nonlinear system





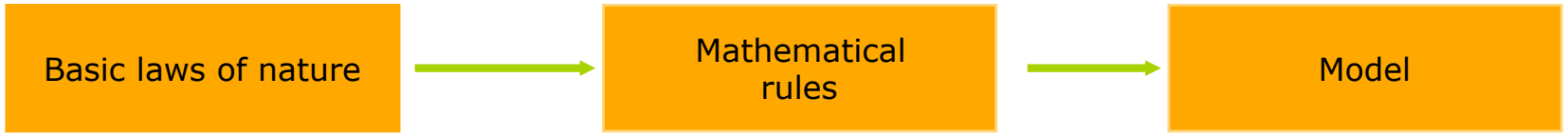
System modelling

- 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

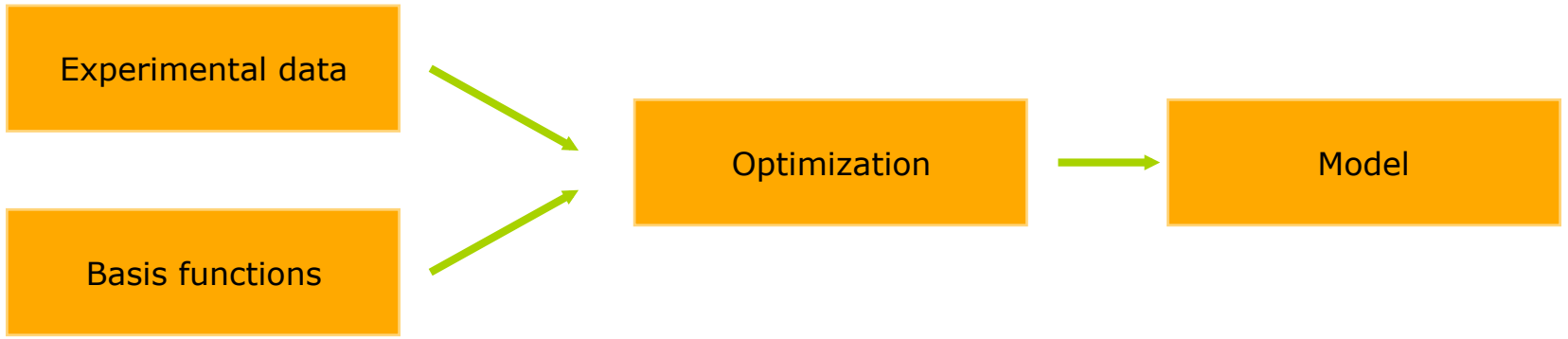
"essentially, all models are wrong, but some are useful”
George E.P. Box

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

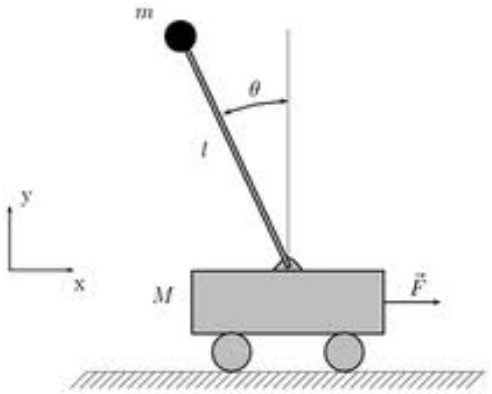
Synthesis

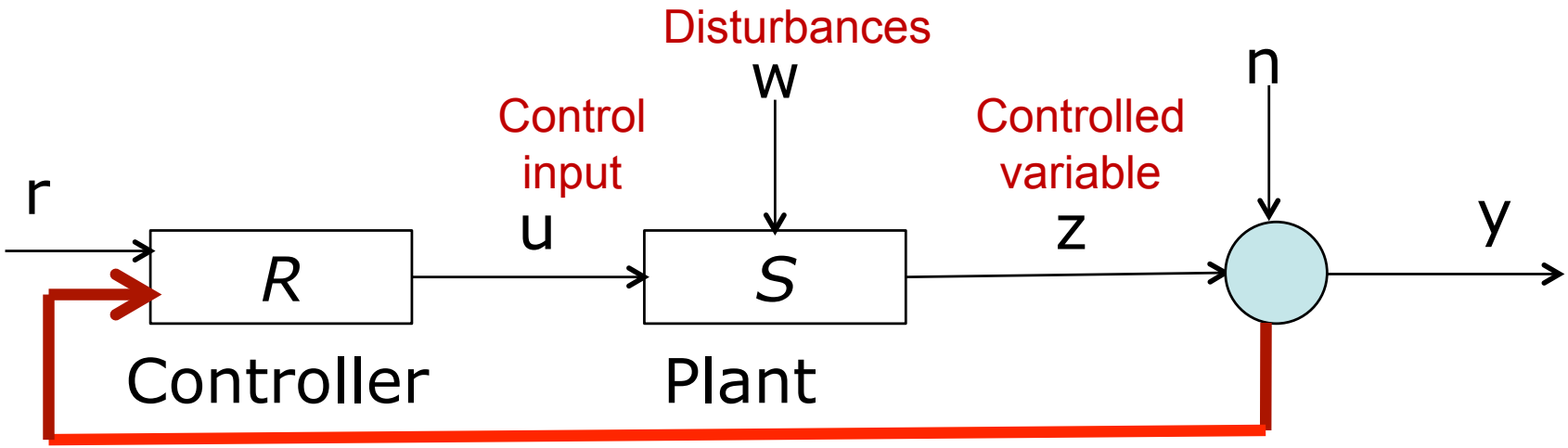
- Design and engineering of processes and systems
- Optimization of systems and processes
- Control
- Process monitoring
- Estimation of inaccessible for measurement quantities (“soft sensors”, “sensor fusion”)

Control systems

Examples:

1. fly-ball governor
2. Speed regulator car
3. Crane.
4. Pendulum.





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