Discrete Event Systems

Automata and Queueing Systems

2019/20

About the instructor

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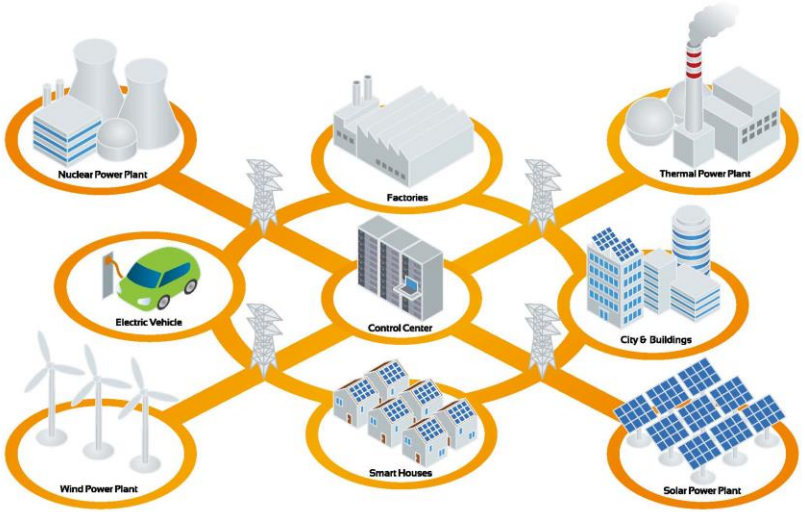
Research interests:

- Robust control
- System identification
- Smart grids



Course schedule

Teaching period:

- From September 30th, 2019 to January 17th, 2020

Timetable:

- Tuesday – from 9AM to 1PM (room F)
- Thursday – from 2PM to 4PM (room F)

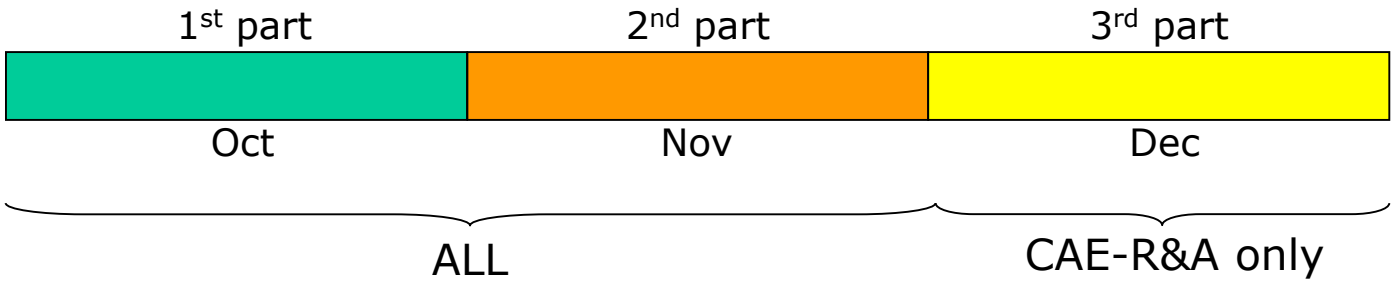
Timing:

- ~ 75% lectures and exercises, ~ 25% lab tutorials

Students

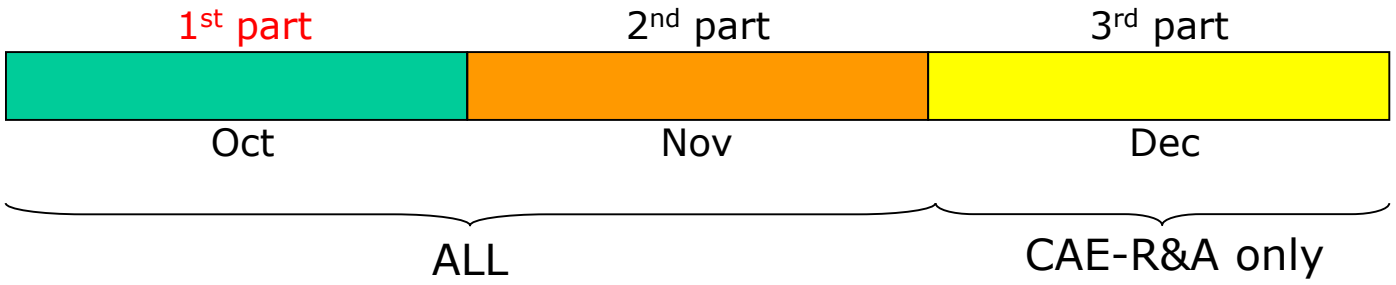
- Automata and Queueing Systems (6 CFU)
  - ✓ MSc Computer and Automation Engineering - Curriculum Information Systems (CAE-IS) – 1st year
  - ✓ MSc Engineering Management (EM) - 1st year
- Discrete Event Systems (9 CFU)
  - ✓ MSc Computer and Automation Engineering - Curriculum Robotics and Automation (CAE-R&A) – 1st year

Timeline



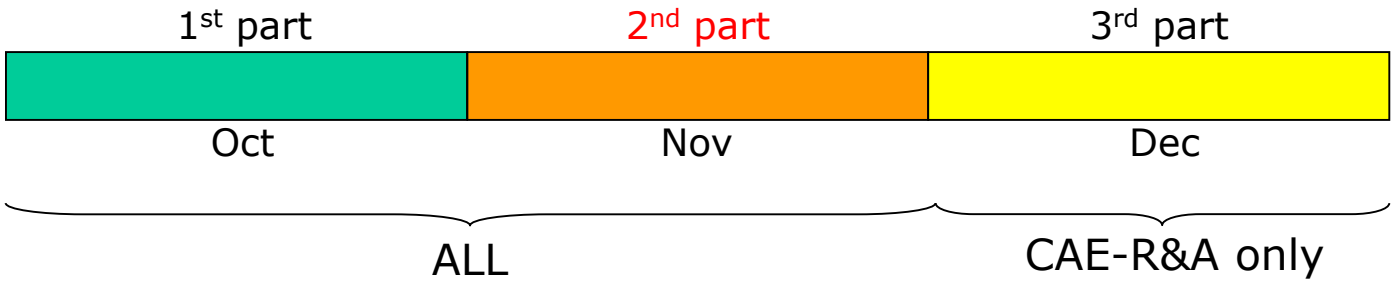
- 1st part + 2nd part: Automata and Queueing Systems
- 1st part + 2nd part + 3rd part: Discrete Event Systems

Syllabus (1/3)



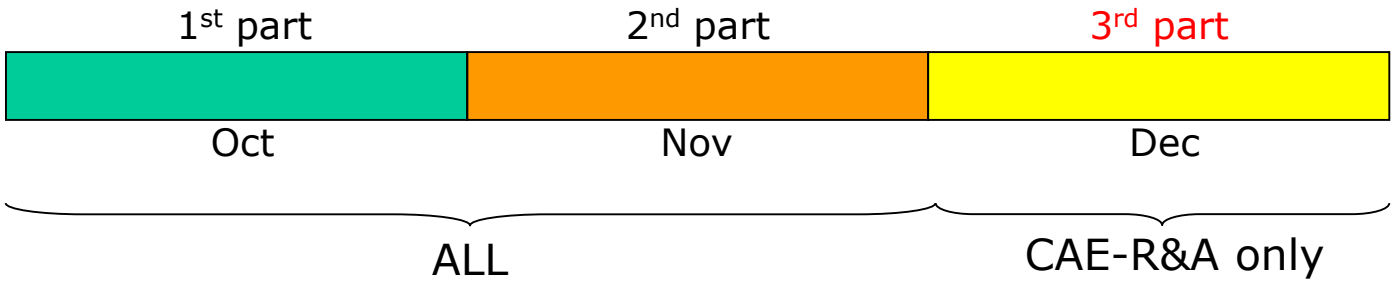
- Logical models of DES
- Timed models of DES
- Stochastic timed models of DES

Syllabus (2/3)



- Simulation of DES
- Continuous-time Markov chains
- Queueing theory

Syllabus (3/3)



- Discrete-time Markov chains
- Control applications of DES

Background and teaching material

Required background:

- Dynamical systems
- Probability

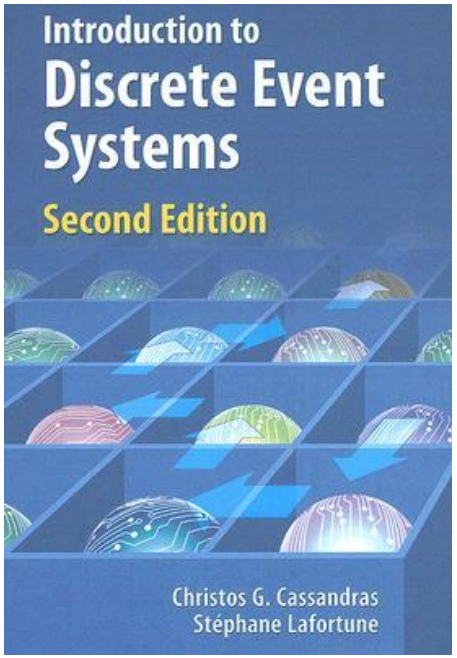
Textbook:

C.G. Cassandras, S. Lafortune,

"Introduction to discrete event systems", 2nd ed.

Springer, 2008

+ lecture notes available on-line

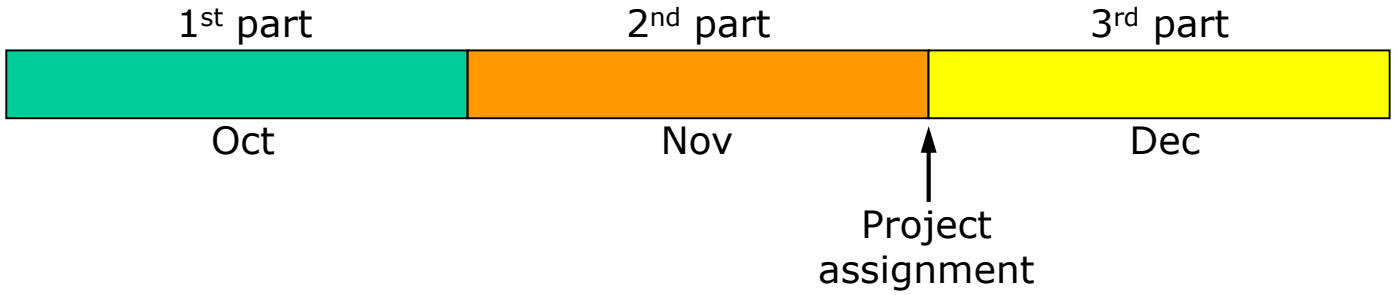


Final exam

- The final exam consists of both a written and an oral test
- The written test consists of exercises
  - ✓ Aid of Matlab is allowed (e.g. for matrix computations)
- The oral test is a broad-spectrum discussion on the topics of the course, including theory and exercises
  - ✓ Enabled only if the grade of the written test is ≥18 out of 30
  - ✓ To be given within the same session as the written test
  - ✓ In case of failure, the student must repeat the written test
  - ✓ The language for the oral test can be either English or Italian
- The final grade is a weighted average of the grades of both tests

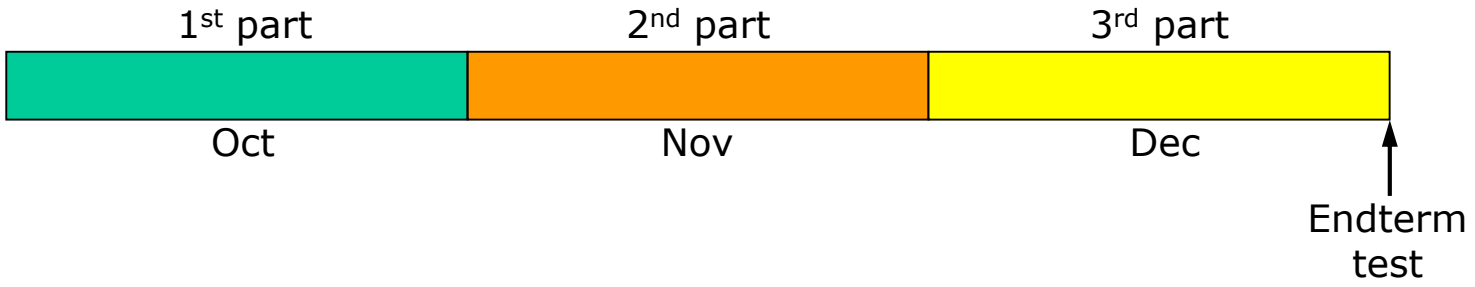
Endterm test and project (1/2)

- The written test of the final exam can be replaced with:
  - ✓ Matlab project + endterm test
- The Matlab project concerns the topics of the 2nd part
  - ✓ Group project (2÷4 members)
  - ✓ To be returned by mid of February at the latest



Endterm test and project (2/2)

- Topics of the endterm test:
  - ✓ CAE-IS and EM: 1st part
  - ✓ CAE-R&A: 1st part + 3rd part



- Oral test enabled only if the average grade of endterm test and project is ≥18 and both grades ≥15 (out of 30)
- One may repeat the endterm test on the first exam date in the winter session of exams

Web-page

General information, lecture notes, exercises, past exams, etc. are available on the course web page:

http://www3.diism.unisi.it/~paoletti/teaching/sed/1920/index.html

Master of Science in Engineering
Università di Siena
Automata and Queueing Systems
Discrete Event Systems
October 2019 - January 2020

Survivor's guide

- Attend ALL the lectures
  - ✓ Integral part of the learning process (notes, questions, etc.)
  - ✓ Enhances student's performance
- Start well
  - ✓ Study from the beginning
  - ✓ Don't expect the endterm test: it's too late…
- Take advantage of office hours
  - ✓ Ask questions, clarify your doubts
  - ✓ Feedback on exercises

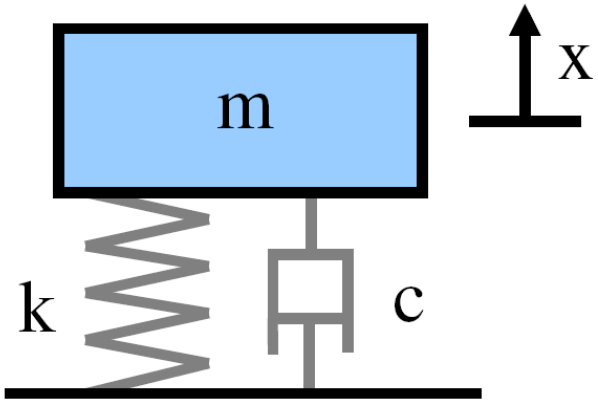
Find the differences…

Damper

Queueing system

Find the differences…

Damper



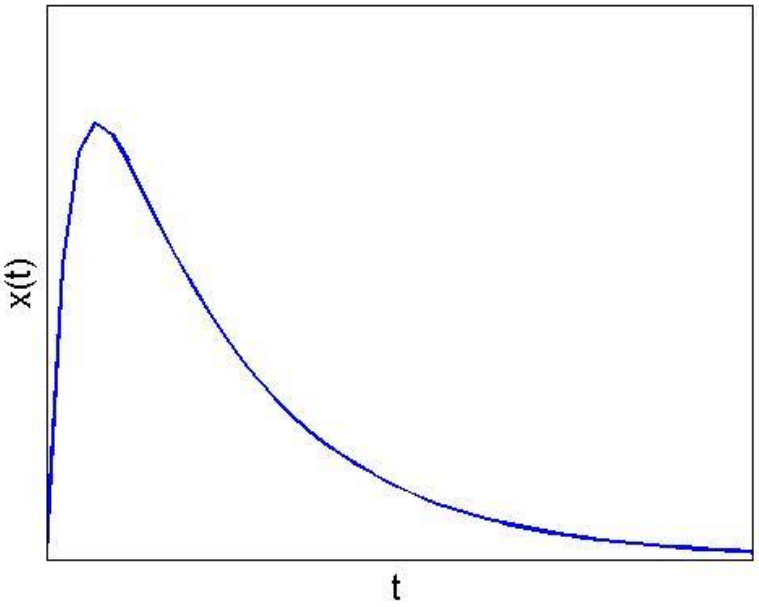
x: mass displacement

Queueing system

x: # of customers in the queue

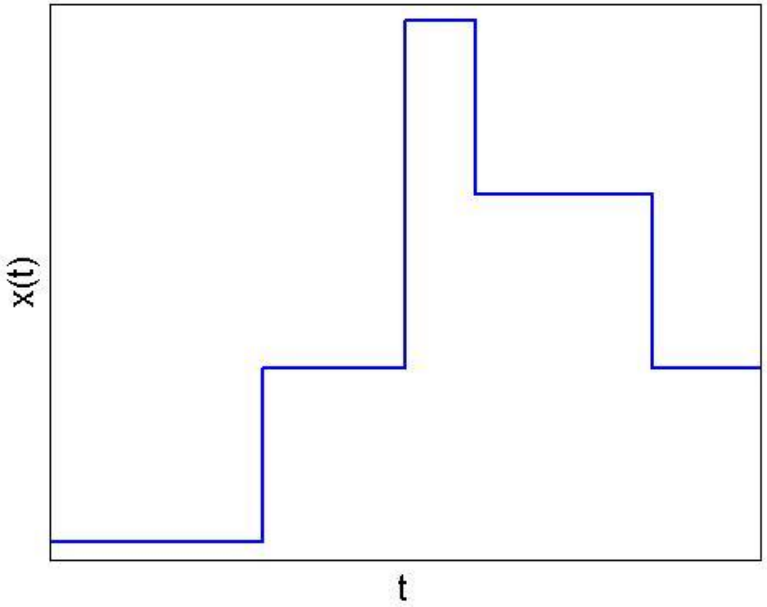
Find the differences…

x: mass displacement



"time-driven" dynamics

x: # of customers in the queue



"event-driven" dynamics

Time-driven vs Event-driven

- **Time-driven** dynamics are typically described by differential equations, e.g.

$$\begin{cases} \dot{x}(t) = Ax(t) + Bu(t) \\ x(t_0) = x_0 \end{cases}$$

- LTI state space equations -

- How can we model **event-driven** dynamics?

Objectives of the course

Modelling, simulation, analysis of **Discrete Event Systems (DES)**

Main contents:

- modelling
- probability
- programming (Matlab)

Which types of models will be considered?

- Logical and timed models (**automata**)
- Markov chains

Main application: **queueing theory**

Examples of discrete event systems (1/3)

- a *manufacturing plant* with machines, workers, conveyor belts, buffers, etc.
- a *bank* with different types of customers and services (desks, ATMs, etc.)
- an *airport* with passengers in different states (check-in, security control, gate, boarding, etc.)
- a *computer system* with resources and processes needing access to resources
- a *road system* with cars, roads, crosses, traffic lights, etc.
- a *fast-food restaurant* with a staff and different types of customers

Examples of discrete event systems (2/3)

- a *switching control system* where it is possible to switch between different controllers
- an *electronic component* subject to deterioration and failures
- etc.

Examples of discrete event systems (3/3)

Summarizing, discrete event systems can be found in:

- control systems
- manufacturing systems
- computer systems
- information networks
- transportation networks
- communication networks
- etc.