

## Quantitative Evaluation of Embedded Systems

**Subject area:** Computer Science/ICT

<b>University:</b>	TU/e
<b>Level:</b>	MA1, MA2, MA all years, PhD
<b>Teaching mode:</b>	hybrid: some students participate online, other students attend real-life
<b>Instructor(s):</b>	Dr.ir. Pieter Cuijpers

### Short description

In this course, you will learn how to model dynamic behavior in an event-based fashion and evaluate quantitative properties of event-based dynamical systems through simulation and analysis. The systems we use as examples throughout this course are mostly taken from the field of Embedded Systems, but the ideas and methods are much more widely applicable.

### Full description

This is a masters course targeting both computer science and engineering students. In its core, it is a challenge based course, built around three major assignments, one focussing on general statistical methods, one focussing on simulation of event-based systems and evaluating statistical performance properties of the modeled systems, and one focussing on analytical models of event-based systems and proving worst/best-case performance properties of those systems. The assignments are broadly phrased and intended to encourage you to go into depth further than "just" the main course material. The main course material is provided mainly through weblectures and recommended reading material. The assignments are made individually, but you will prepare for them by discussing questions about the course material and by discussing the assignments themselves in organized study groups twice a week. The outcome of those discussions are reported back in an online forum, and the teacher reflects on those outcomes regularly with you through online classroom sessions and by visiting the studygroups in person. After handing in your assignment, you will be asked to perform a peer review of the assignments of fellow students, based on a rubric that is provided as part of the assignment itself. This peer reviewing is intended to help you reflect on the topic, on the quality of your own work in comparison to the work of others, to help you to deepen your understanding of the topic by explaining it to others, and of course it also helps the teacher in making the final assessment (both by looking at your work, at how it was reviewed by your peers, and by looking at how you reviewed the work of others).

## Learning outcomes

At the end of the course, the student is able to perform a rigorous performance evaluation of event-based models of embedded systems. In particular, the student masters simulation techniques to evaluate latency, throughput, buffering and utilization properties, and can write a detailed reflection on the statistical meaning and scope of such an evaluation. Furthermore, the student is able to perform a worst-case analysis of these metrics, and write a detailed reflection on validity of and the assumptions underlying such an analysis. The student is aware of how this performance evaluation may be used for design-space exploration purposes, as well as of the theoretical underpinning of the methods learned (e.g. Monte Carlo methods, Markov chains, and dataflow graphs). During the course, the student has gained hands-on experience applying the learned theory and methods to an embedded streaming application using state-of-the-art modelling tools. (Currently, the assignments focus on Matlab and the Matlab SimEvents toolbox. In the past, we have also used the SDF3 and dataflow modeller toolsets, UPPAAL, PRISM, as well as modelling in Python. If you have a specific preference or suggestions for alternative tools, please contact the teacher well in advance of the course).

## General information

<b>Contact hours per week:</b>	4
<b>Total workload:</b>	140 (excl. homologation needs) (in student hours for the whole course)
<b>ECTS credits:</b>	5
<b>Language:</b>	English
<b>Course start date:</b>	06 February 2023
<b>Course end date:</b>	23 April 2023
<b>Add. info about start date:</b>	
<b>Weekly teaching day/time:</b>	Tuesday 10:45 - 12:30, Friday 15:30 - 17:15
<b>Time zone:</b>	CET (Denmark, Germany, France, Netherlands, Switzerland, Czech Republic)

### Further information:

**Prerequisites:** For this course, a basic knowledge of linear algebra (matrix calculations), probability theory (the notion of probability and independence of experiments) and automata / process theory (modelling using transition systems) is assumed. Also, basic familiarity with Matlab is assumed. However, there is no formal requirement on having followed specific courses on these subjects. If you notice you are missing some preliminary theory, the provided reading material within the course should be helpful to get you up to speed, but you may notice you need to spend more time on the course than the prescribed 5 ects or than other students who do have this preliminary knowledge.

**Activities and methods:** Group work, Self-study, Tutorial sessions, Weblectures

**Presence on campus:** Not required, provided sufficiently many students want to follow the course online.

## Final examination

**Form:** assignment

**Date:**

**Location/format:** online

**Re-sit possibility:** yes

**Transcript available:**

**Add. info/requirements:** Three assignments handed in throughout the course. Deadlines will be fixed because of peer-reviewing process. In case a resit is needed for one or more of the assignments, this is usually possible in combination with an oral examination.

## Registration

To register for this course, follow the registration requirements of your **home university** as specified here: [www.euroteq.eu/courses-registration](http://www.euroteq.eu/courses-registration).

## Administration

**Number of places:** 10

**Minimum participants:** 6 EuroTeQ students, so they can form a study group together.

**Internal course code:** 2IMN25

**Contact:** [p.j.l.cuijpers@tue.nl](mailto:p.j.l.cuijpers@tue.nl)

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*This course is part of the EuroTeQ Engineering University joint course catalogue 2023. This is a collaborative activity of the partner universities DTU, L'X, TU/e, TalTech, CTU, TUM as well as Technion. Students from these universities can participate in the offered courses. It is the responsibility of the student to check if you fulfil the requirements to participate in a specific course. Students are also advised to check with their home institution how to get recognition of the ECTS credits gained in courses of the EuroTeQ course catalogue. For further information about EuroTeQ Engineering University, visit [www.euroteq.eu](http://www.euroteq.eu) or get in touch with the above-mentioned point of contact.*