GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2017-2018

Queueing Analysis and Simulation (E011322)

Course size *(nominal values; actual values may depend on programme)*

Credits 6.0 **Study time 180 h** **Contact hrs** 60.0 h

Course offerings and teaching methods in academic year 2017-2018

A (semester 1)	project	1.25 h
	seminar: coached exercises	22.5 h
	lecture	30.0 h
B (semester 1)	self-reliant study activities	0.0 h
	project	1.25 h

Lecturers in academic year 2017-2018

Fiems, Dieter	TW07	lecturer-in-charge
Walraevens, Joris	TW07	co-lecturer

Offered in the following programmes in 2017-2018	crdts	offering
Bridging Programme Master of Science in Electrical Engineering (main subject Communication and Information Technology)	6	A
Bridging Programme Master of Science in Computer Science Engineering	6	B
Bridging Programme Master of Science in Computer Science Engineering	6	A
Master of Science in Electrical Engineering (main subject Communication and Information Technology)	6	A
Master of Science in Electromechanical Engineering (main subject Control Engineering and Automation)	6	A
Master of Science in Electromechanical Engineering (main subject Electrical Power Engineering)	6	A
Master of Science in Electromechanical Engineering (main subject Maritime Engineering)	6	A
Master of Science in Electromechanical Engineering (main subject Mechanical Construction)	6	A
Master of Science in Electromechanical Engineering (main subject Mechanical Energy Engineering)	6	A
Master of Science in Computer Science	6	A
Master of Science in Mathematical Informatics	6	A
Master of Science in Computer Science Engineering	6	B
Master of Science in Computer Science Engineering	6	A
Exchange Programme in Computer Science (master's level)	6	A

Teaching languages

Dutch, English

Keywords

Queueing systems; Stochastic modelling; Performance evaluation of computer and communication systems; Markov chains; Simulation.

Position of the course

This course introduces basic concepts of queueing analysis and simulation for assessing the performance of computer and communication systems. Specifically, the course discusses techniques for dimensioning queues and buffers and for the

estimation of loss probabilities, blocking probabilities and delays in such queues.

Contents

- Introduction: Queues in communication networks and computers; Stochastic modelling; Terminology of queueing systems; Kendall notation.
- Birth-death queueing systems: Poisson arrivals see time averages; Global and detailed balance equations; Erlang's formulas.
- Waiting times: Little's law; Waiting time analysis of first-come-first-served birth-death queueing systems; Laplace-Stieltjes transform approach.
- Quasi-birth-death queueing systems: Phase-type distribution; Markovian arrival process; Numerical solution of quasi-birth-death Markov chains.
- Queues with generally distributed service times: Mean-value analysis; Transform analysis; Calculation/approximation of performance measures from transforms.
- Networks of queueing systems: Reversibility of Markov chains; Burke's theorem; Jackson networks.
- Pseudo random number generators: Generic description and desirable properties of pseudo random number generators; Linear congruential generators; Inversion method; Box-Mueller algorithm; Acceptance-Rejection method.
- Simulation: Monte Carlo simulation; Simulating trajectories of discrete and continuous-time Markov chains; Discrete-event simulation; Confidence intervals; Batch-means method; Comparison of scheduling disciplines for queues.
- Variance reduction techniques: Antithetic method; Reduction by conditioning; Reduction by control variates; Importance sampling.

Initial competences

Basic probability theory and statistics; elements of stochastic processes in general, and Markov chains in particular

Final competences

1 To master mathematical solution techniques for queueing problems
2 To construct a simulation program and to process simulation results
3 To select the most suitable models, methods and techniques for specific queueing problems
4 To assess the performance of queueing systems quantitatively and qualitatively

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Lecture, project, self-reliant study activities, seminar: coached exercises

Learning materials and price

Course material: English syllabus + slides (via Minerva)

References

- M. Harchol-Balter, Performance Modeling and Design of Computer Systems: Queueing Theory in Action, Cambridge University Press, 2013.
- L. Kleinrock, "Queueing Systems, Volume 1, Theory" (Wiley, New York, 1975)

Course content-related study coaching

Evaluation methods

end-of-term evaluation and continuous assessment

Examination methods in case of periodic evaluation during the first examination period

Written examination with open questions

Examination methods in case of periodic evaluation during the second examination period

Written examination with open questions

Examination methods in case of permanent evaluation

Report

Possibilities of retake in case of permanent evaluation

examination during the second examination period is possible

Calculation of the examination mark

Examination: 80%
Project: 20%