

750742, Theory of Concurrency

3 hours per week, 3 credit hours, prerequisite: **none**

Teaching Method: 37 hours Lectures (2-3 hours per week), 8 hours Seminars (1 per 2 weeks)

Aims: This module aims to teach mathematical foundations to understand *models* of concurrent programs and reactive systems. The module covers basic techniques to describe the form and meaning of program terms and to reason about them (proving concurrent programs correctness).

The

module will be accompanied by pencil-and-paper as well as computer-aided verification exercises.

Learning Outcomes:

On completion of this module, the student should:

- Understand the mathematical foundations of concurrent programs.
- Have knowledge on proving concurrent programs correctness.
- Be able to write concurrent programs and prove their correctness.

Textbooks and Supporting Materials:

I. Textbooks

- 1- Michael Huth and Mark Ryan, Logic in Computer Science Modeling and Reasoning about Systems, Cambridge Press, 2004.
- 2- Fokkink, Wan, Introduction to Process Algebra, Series: Texts in Theoretical Computer Science. An EATCS Series, 2000, VIII, 163 p. 11 illus.
- 3- Robert Milner, Communicating and Mobile Systems: The Π -Calculus,
- 4- Formal Methods for Mobile Computing, 5th International School on Formal Methods for the Design of Computer, Communication, and Software Systems, SFM-Moby 2005, Bertinoro, Italy, April 26-30, 2005, Advanced Lectures, Series: Lecture Notes in Computer Science, Vol. 3465

5- Rewriting Techniques and Applications, 11th International Conference, RTA 2000, Norwich, UK, July 10-

12, 2000 Proceedings, Series: Lecture Notes in Computer Science, Vol. 1833, Bachmair, Leo (Ed.) 2000, X, 275 p.

6- W. Reisig, G. Rozenberg (Eds.), Lectures on Petri Nets I: Basic Models, Advances in Petri Nets, Lecture Notes in Computer Science, Vol. 1491, Springer-Verlag, 1998.

7- Jörg Desel, Wolfgang Reisig, Grzegorz Rozenberg (Eds.), Lectures on Concurrency and Petri Nets, Advances in Petri Nets, Lecture Notes in Computer Science, Vol. 3098, Springer-Verlag, 2004, ISBN: 3-540-22261-8.

II. Selected Research papers

III. Selected Software Tools.

Synopsis:

1. Concurrency: Concurrent Programs; Non determinism, Synchronization, Communication; Correctness of concurrent programs.
2. Properties of concurrent programs: Liveness; Safety.
3. Models of concurrency: Interleaving; True concurrency.
4. Labeled Transition Systems: Transition Systems and notion of equivalence; Sequential processes and Bisimulation; Concurrent processes and Bisimulation; Basics on mobile processes (Π calculus); Reasoning about mobile processes.
5. Petri Nets: Generalities; Basic formal definitions; Petri nets properties; Verification techniques; High level Petri nets.
6. Rewriting Logic: Generalities; Basic formal definitions; Rewriting logic as a Semantics for true concurrency; Proof techniques.

Assessment: Two 1-hour midterm exams (15% each); Assignments (10%); Seminars (10%); 2-hours

Final Exam (50%)