

Mathematical Simulation Techniques					AR-308
Rota	Duration	Semester	SWS	Credit Points	Workload
annually WS or SS	1 Semester	2 nd / 3 rd	3 SWS	5	150 h
1	Modul Structure				
	Course (Abbreviation)	Type/ SWS	Presence	Self Study	Credit Points
	a) Mathematical Simulation Techniques (MST)	Lecture/ 2 SWS	25 h	65 h	3
	b) Mathematical Simulation Techniques (MST)	Tutorial/ 1 SWS	15 h	45 h	2
2	Language: English				
3	<p>Content: Discretization and solution techniques for the numerical simulation of problems in continuum mechanics, as well as their efficient treatment on computer systems are introduced. The course Advanced Engineering Mathematics, a solid background in mathematics, and solid programming skills are assumed. Among the subjects are the following:</p> <ol style="list-style-type: none"> <u>Practical finite elements:</u> Variational formulation of partial differential equations, weak solutions, Ritz-Galerkin techniques, finite element approximation and analysis, numerical integration, boundary approximation, mesh generation, error control and reliability, solution of linear systems. <u>Computational aspects of fluid dynamics:</u> Conservation laws, compressible and incompressible fluids, spatial discretization (FD, FV, FEM), stabilization techniques, explicit and implicit time stepping schemes, treatment of boundary conditions, projection- and operator-splitting -techniques. <u>High performance computing:</u> Parallel computer architecture, performance-oriented programming, sparse numerical linear algebra, Krylov-subspace and multigrid solvers, preconditioning strategies, domain decomposition methods, shared and distributed memory parallelization with OpenMP and MPI, GPU Computing. <u>Approximation theory:</u> Interpolation and approximation, polynomial spaces, splines and Bézier curves, existence and uniqueness, best-approximation properties, quasi-interpolation, quality assessment and error analysis. <p>Literature: References will be given in the courses.</p>				
4	<p>Competencies</p> <p>This course provides students with fundamental mathematical simulation techniques that are essential to solve automation problems in robotics as well as in production and engineering processes of all kinds. The entire simulation pipeline is covered in theory and practice. Students are trained to solve real-life complex problems in “Numerics Labs”.</p>				
5	<p>Examination Requirements</p> <p>The final exam will be an oral (20 minutes) or written (1.5 hours) exam, depending on the number of participants (form will be announced in the second week of the course).</p>				
6	<p>Formality of Examination</p> <p><input checked="" type="checkbox"/> Module Finals <input type="checkbox"/> Accumulated Grade</p>				
7	<p>Module Requirements (Prerequisites)</p> <p>Course: “Advanced Engineering Mathematics”, solid programming skills</p>				
8	<p>Allocation to Curriculum:</p> <p>Program: Autom. & Robot., Field of study: Robotics, Process Automation, Cognitive Systems</p>				
9	<p>Responsibility/ Lecturer</p> <p><i>Dean of the Mathematics faculty / Lecturers of the Mathematics faculty</i></p>				