Mathematical Methods

1	**Module Number**	**Study Programme**	**Semester**	**Offered in**	**Duration**	**Module Type**	**Workload (h)**	**ECTS Points**
	3901	ASM	1	☒WS ☐SS	1 Semester	compulsory	240	-8

2	**Courses**	**Teaching and Learning Forms**	**Contact Time**		**Self-Study Time**	**Language**
			(SWS)	**(h)**	**(h)**	
	a) Numerical Analysis	Lecture	3	45	120	English
	b) Numerical Differential Equations	Lecture	2	30		
	c) Statistics and Kalman Filter	Lecture	3	45		
				[1 SWS = 15h]		

3 **Learning Outcomes and Competences**

Once the module has been successfully completed, the students can...

Knowledge and Understanding

- ... explain the basic ideas of numerical analysis and understand the relation to the applications
- ... understand the algorithms and their constraints
- ... understand the limitations of the algorithms

Use, Application and Generation of Knowledge

Use and Transfer

- ... apply the algorithms in MATLAB.
- ... analyse the solutions concerning plausibility.
- … recognize and classify connections.
- ... analyse technical problems and derive or develop solutions.
- ... familiarize themselves with new ideas and topics based on their basic knowledge.

Scientific Innovation

- … use methods and tools to gain new insights in the field of numerical analysis.
- ... create new models.
- ... optimize systems.
- ... independently develop approaches for new concepts and assess their suitability.
- ... develop concepts for the optimization of technical applications.

Communication und Cooperation

- ... interpret the results of numerical analysis and draw admissible conclusions.
- ... use the learned knowledge, skills and competences to evaluate the field and interpret them according to other aspects.
- ... communicate and cooperate within the group in order to find adequate solutions for the task at hand.

Scientific Self-Conception/ Professionalism

- ... justify the solution theoretically and methodically.

4 **Contents**

Lecture a)

- Linear systems
- Regression
- Numerical differentiation and integration
- Nonlinear equations and nonlinear systems

Lecture b)

- Ordinary differential equations (Runge-Kutta methods, stability and stiffness, shooting methods, applications)
- Partial differential equations (finite difference methods, finite element methods, applications)

Lecture c)

	• Descriptive and inferential statistics • Probability theory • Kalman filter Programming in MATLAB as part of the lecture.
5	**Participation Requirements** compulsory: - recommended: Good knowledge of further mathematics
6	**Examination Forms and Prerequisites for Awarding ECTS Points** Written Examination, 120 minutes
7	**Further Use of Module** Applying mathematical methods in other lectures and major fields of automotive engineering
8	**Module Manager and Full-Time Lecturer** Prof. Dr. J. Gaukel, Prof. Dr. M. Stämpfle, Prof. Dr. G. Schaaf
9	**Literature** • Gander W., Gander M.J., Kwok, F., Scientific Computing • Stanoyevitch, Introduction to Numerical Ordinary and Partial Differential Equations Using MATLAB, Wiley • Marchthaler, Dingler: Kalman-Filter: Einführung in die Zustandsschätzung und ihre Anwendung für eingebettete Systeme • Chui, Chen: Kalman Filtering, Springer
10	**Last Updated** 06.10.2022