

Module description: Numerics	
Module Code	t.BA.XXM6.NUM.22HS
ECTS Credits	4
Language of Instruction/Examination	German
Organizational Unit	IAMP
Module Coordinator	Nadin Stahn
Legal Framework	The module description is part of the legal basis in addition to the general academic regulations. It is binding. During the first week of the semester a written and communicated supplement can specify the module description in more detail.
Module Characteristic	Type 3a 2 lecture lessons per semester week and class+ 2 weekly lab lessons per semester and half-class
Module Description	Introduction to numerical methods for engineers.
Module Content	Fundamental terms and basic concepts of numerics Linear equations • Condition, Triangular matrices, LR decomposition • Cholesky decomposition, Tridiagonal matrices Linear least squares methods • Normal equation • Cholesky method, (optional) QR decomposition Nonlinear equations • Bisection method, Newton- and fixed point iteration • Nonlinear least square method • Multidimensional Newton method Interpolation and integral approximation • Lagrange interpolation polynomial function • Newton-Côtes-formula for integral approximation • Introduction to cubic splines Numerical methods for differential equations • Discretization error, convergence • One-step procedure - for details look comments • (optional) step size control • finite difference method for one-dimensional boundary value problems
Prerequisite Knowledge	• Analysis I - III • Algebra and Statistics I & II • Programmieren 1

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Learning Objectives (Competences)	Students...			Competencies	Taxonomies	
	Providing the analytical and numerical tools needed in engineering subjects. Introduction to the way of thinking of discrete and numerical mathematics. To convey the role of applied mathematics in science and technology.			F, M	K1, K3	
	You know the terms consistency, convergence, local/global error, error order, stability. You can calculate and visualize both local and global errors for suitable examples.			F, M	K3	
	You know important algorithms and numerical parameters for solving linear systems of equations and apply them correctly using examples.			F, M	K3	
	You are able to solve linear least square problems with the help of Cholesky decomposition and know the geometrical interpretation of the normal equation.			M, F	K3	
	You are able to solve nonlinear equations and systems of equations with appropriate methods iterative.			F, M	K2, K3	
	You can solve nonlinear compensation problems with the help of the approach of linearisation and the Gauss-Newton-method.			M, F	K3	
	You can interpolate data using the polynomial approach by Lagrange and using cubic splines.			F, M	K3	
	You know common explicit as well as implicit one-step procedures, e.g. procedures according to Euler, Runge, Trapez, classical Runge-Kutta, Heun, and can use them for the approximate solution of initial value problems.			M, F	K3	
	You can use finite differences to solve one-dimensional boundary value problems.			F, M	K3	
	You are able to approximate a definite integral using Newton-Côtes-Formula.			F, M	K3	
Performance Assessment	End-of-module exam	Assessment	Length (min.)	Weighting	Form	
	written exam		120	80	acc. to module agreement	
	Performance assessment during the semester		Assessment	Length (min.)	Weighting	Form
	Practicum		Grade		20	acc. to module agreement
Classroom Attendance Requirement	None					
Learning material	• Script • Excercises • Practica					

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Comments

The implementation of numerical methods on the computer is an integral part of the lecture.

Contents details:

Explicit and implicit numerical methods

Explicit: Euler, Runge, Heun, classic Runge-Kutta

Implicit: Euler, trapezoid, center point rule