Department of Computer Science
Saarland University

Module Descriptions

Master Program Visual Computing

Mandatory Elective Courses:
Mandatory elective courses give students a restricted choice. Students must complete a certain number of mandatory elective courses from a set of options to fulfil a certain category given by the examination regulations.

Elective Courses:
Not all courses chosen need necessarily come from the degree program being studied. Some courses offered by other faculties in the UdS can be used to contribute credit points towards the final degree.

Image Acquisition Methods and Geometric Foundations

Program of Studies:	Master Program Visual Computing
Name of the module:	Introduction to Image Acquisition Methods
Abbreviation:	CS 750 / IIAM
Subtitle	
Modules:	Lecture 2 h (weekly)
Semester:	1st-3rd Semester
Responsible lecturer:	Prof. Dr. Joachim Weickert
Lecturer(s):	Dr. Martin Welk
Language:	English
Level of the unit / mandatory or not:	Graduate Course / Mandatory Elective
Course Type / weekly hours:	Lecture 2 h (weekly)
Total workload:	120 h = 30 h classes and 90 h private study
Credits:	4
Entrance requirements:	
Aims / Competences to be developed:	The course is designed as a supplement for image processing lectures, to be attended before, after or parallel to them. Participants shall understand - what are digital images - how they are acquired - what they encode and what they mean - which limitations are introduced by the image acquisition. This knowledge will be helpful in selecting adequate methods for processing image data arising from different methods.
Content:	A broad variety of image acquisition methods is described, including imaging by virtually all sorts of electromagnetic waves, acoustic imaging, magnetic resonance imaging and more. While medical imaging methods play an important role, the overview is not limited to them.

	Starting from physical foundations, description of each image acquisition method extends via aspects of technical realisation to mathematical modelling and representation of the data. Used media: Beamer
Assessment / Exams:	• Written or oral exam at end of course • A re-exam takes place during the last two weeks before the start of lectures in the following semester.
Used Media:	Slides, beamer
Literature:	• B. Jähne, H. Haußecker, P. Geißler, editors, Handbook of Computer Vision and Its Applications. Volume 1: Sensors and Imaging. Academic Press, San Diego 1999. • S. Webb, The Physics of Medical Imaging. Institute of Physics Publishing, Bristol 1988. • C. L. Epstein, Introduction to the Mathematics of Medical Imaging. Pearson, Upper Saddle River 2003. • C. Kak, M. Slaney, Principles of Computerized Tomographic Imaging. SIAM, Philadelphia 2001. • Articles from journals and conferences.

Program of Studies:	Master Program Visual Computing
Name of the module:	Medical Imaging
Abbreviation:	
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1^{st}-3^{rd} Semester
Responsible lecturer:	Prof. Dr. Alfred Louis
Lecturer(s):	Prof. Dr. Alfred Louis
Language:	German
Level of the unit / obligatory or not:	Graduate Course / Mandatory Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Total workload:	270 h = 90 h classes and 180 h private study
Credits:	9
Entrance requirements:	
Aims / Competences to be developed:	The lecture teaches mathematical models in x-ray and ultrasound tomography, the related integral equations, questions of resolution and fast algorithms.
Content:	Mathematical models for x-ray CT, ultrasound and new imaging methods The related integral transforms, like Radon, X-ray transform and the Lippmann Schwinger equation Sampling theorems : Shannon and Petersen-middelton Resolution and nonuniqueness Methods like filtered backprojection, ART, incomplete data problems Nonlinear problems Numerical examples from real data
Assessment / Exams:	Regular attendance of classes and tutorials Passing of examination (final, re-exam)
Used Media:	Blackboard, Beamer

Literature:	Louis: Inverse und schlecht gestellte Probleme, Teubner, 1989 Natterer-Wübbeling: Mathematical methods in image reconstruction, SIAM 2001 Kak-Slaney: Principles of computerized tomographic imaging, SIAM 2001

Program of Studies:	Master Program Visual Computing
Name of the module:	Bildgebende Verfahren I: Röntgen und Ultraschall
Abbreviation:	
Subtitle	
Modules:	Lecture 2 h (weekly)
Semester:	1st-3rd Semester
Responsible lecturer:	Dr. Robert Lemor
Lecturer(s):	Dr. Robert Lemor
Language:	German (offered in English if requested by sufficiently many people)
Level of the unit / obligatory or not:	Mandatory Elective
Course Type / weekly hours:	Lecture 2 h (weekly)
Total workload:	120 h = 30 h classes and 90 h private study
Credits:	4
Entrance requirements:	
Aims / Competences to be developed:	Grundlegendes Wissen auf den Gebieten: Röntgen und Ultraschall Bildgebung in medizinischen Anwendungen
Content:	Röntgenstrahlung- Erzeugung, Ausbreitung, Detektion, Signalverarbeitung, Bildgebung, Tomographie, Fourier-Slice Theorem Ultraschall - Erzeugung, Schallfeldformung, Ausbreitung, Detektion, Signalverarbeitung, Bildgebung, Bildgebunsgmodi Fourier Transformation, Faltung, Korrelation, Übertragungsfunktion, Hilbert Transformation, Amplituden Demodulation, Doppler Demodulation
Assessment / Exams:	Written exam at the end of the course
Used Media:	Blackboard
Literature:	Script

Program of Studies:	Master Program Visual Computing
Name of the module:	Imaging Methods: MRI
Abbreviation:	
Subtitle	Basics and Applications of Magnetic Resonance Imaging
Modules:	Lecture 2h (weekly) Tutorial 1h (weekly)
Semester:	1st-3rd Semester
Responsible lecturer:	PD. Dr. rer.nat. habil. Frank Volke
Lecturer(s):	PD. Dr. rer.nat. habil. Frank Volke
Language:	English
Level of the unit / obligatory or not:	Graduate Course / Mandatory Elective
Course Type / weekly hours:	Lecture 2h (weekly) Tutorial 1h (weekly)
Total workload:	150h = 45 classes and 105 self study
Credits:	5
Entrance requirements:	Basic physics and mathematics
Aims / Competences to be developed:	The lecture teaches basic and understandable physics and mathematics of the non-invasive imaging method : MRI (Magnetic Resonance Imaging), with the aim, to enable the student to understand image analysis, and finally be able to design own experiments.
Content:	1. Basics 2. Physics /Mathematics 3. Signals, Manipulation, Filters, Images 4. Frequency /space encoding 5. Imaging Methods, e.g. back-projection 6. Applications in Life- and Material Sciences: health, plants, aviation and more. 7. Tutorial: group of up to 4 students after appointment.
Assessment / Exams:	Interactive lectures with questions to be pointed. Students short presentations (10 min). Own “smart” programming (extra points). Passing 1 written exam. Final examination (group of 2 to 3 Students, 1 hour).
Used Media:	Beamer, Bord, Multimedia

Literature:	Internet “NMR MRI”

Program of Studies:	Master Program Visual Computing
Name of the module:	Geometric Modeling
Abbreviation:	CS 576 / GM
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1st -3rd Semester / At least once every two years
Responsible lecturer:	Prof. Dr. Hans-Peter Seidel
Lecturer(s):	Prof. Dr. Hans-Peter Seidel, Prof. Dr. Philipp Slusallek
Language:	English
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 25 students
Total workload:	270 h = 90 h of classes and 180 h private study
Credits:	9
Entrance requirements:	For graduate students: none
Aims / Competences to be developed:	Learning working knowledge of theoretical and practical methods for solving geometric modeling problems on a computer.
Content:	• Polynomial Curves • Bezier and Rational Bezier Curves • B-splines, NURBS • Tensor Product Surfaces • Shape Interrogation Methods • Mesh Processing • Multiresolution Modeling
Assessment / Exams:	• Regular attendance of classes and tutorials • Weekly Assignments (40%) • Midterm exam (20%)

	• Final exam (40%) • A re-exam takes place during the last two weeks before the start of lectures in the following semester.
Used Media:	Slides, beamer
Literature:	• G. Farin. *Curves and surfaces for Computer-Aided Geometric Design*, Academic Press • J. Hoschek and D. Lasser. *Grundlagen der geometrischen Datenverarbeitung*, Teubner *(original German version) Fundamentals of computer aided geometric design*, AK Peters *(English translation)* • C. de Boor. *A practical Guide to Splines*, Springer • N. Dyn. *Analysis of Convergence and Smoothness by the Formalism of Laurent Polynomials. In:* A. Iske, E. Quak, M. S. Floater. *Tutorials on multiresolution in geometric modelling: summer school lecture notes.* • J. Warren and H. Weimer. *Subdivision methods for geometric design: a constructive approach.* • P. Schröder, D. Zorin. *Subdivision for modelling and animation. SIGGRAPH 2000 course notes*

Program of Studies:	Master Program Visual Computing
Name of the module:	Effective Computational Geometry for Curves and Surfaces
Abbreviation:	CS 650 / ECG
Subtitle	
Modules:	Lecture 4 h (weekly)
Semester:	1st-3rd Semester / At least once every two years
Responsible lecturer:	Prof. Dr. Kurt Mehlhorn
Lecturer(s):	Lutz Kettner, Kurt Mehlhorn, Susanne Schmitt, Nicola Wolpert
Language:	English
Level of the unit / mandatory or not:	Graduate / Mandatory Elective
Course Type / weekly hours:	Lecture 4 SWS
Total workload:	180 h = 70 h classes, 110 h private study
Credits:	6
Entrance requirements:	Related core lecture Algorithms and Data Structures
Aims / Competences to be developed:	Our goal is the development of data structures and of efficient and exact algorithms for boolean operations on curved polygons and curved polyhedra.
Content:	In the lecture we address common problems in the implementation of algorithms in computational geometry, in particular, new questions when known methods for segments and lines are extended to curves and surfaces. We start with the traditional sweep-line algorithm and randomized- incremental construction. We discuss arithmetic precision, separation bounds, floating point filters, computation with algebraic numbers, curves and curve arrangements, quadric surfaces and surface arrangements, software structure of LEDA and CGAL, and C++ techniques.
Assessment / Exams:	Homeworks, Oral Exam
Used Media:	Blackboard
Literature:	An updated list of relevant literature will be published at the begining of the lecture.

Image Analysis

Program of Studies:	Master Program Visual Computing
Name of the module:	Image Processing and Computer Vision
Abbreviation:	CS 572 / IPCV
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1^{st} -3^{rd} Semester / At least once every two years
Responsible lecturer:	Prof. Dr. Joachim Weickert
Lecturer(s):	Prof. Dr. Joachim Weickert
Language:	English
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 25 students
Total workload:	270 h = 90 h of classes and 180 h private study
Credits:	9
Entrance requirements:	For graduate students: none
Aims / Competences to be developed:	Broad introduction to mathematical methods in image processing and computer vision. The lecture qualifies students for a bachelor thesis in this field. Together with the completion of advanced or specialised lectures (9 credits at least) it is the basis for a master thesis in this field.
Content:	1. Basics 1.1 Image Types and Discretisation 1.2 Degradations in Digital Images 2. Image Transformations 2.1 Fourier Transform 2.2 Image Pyramids 2.3 Wavelet Transform 3. Colour Perception and Colour Spaces 4. Image Enhancement 4.1 Point Operations

	4.2 Linear Filtering 4.3 Wavelet Shrinkage, Median Filtering, M-Smoothers 4.4 Mathematical Morphology 4.5 Diffusion Filtering 4.6 Variational Methods 4.7 Deblurring 5. Feature Extraction 5.1 Edges 5.2 Corners 5.3 Lines and Circles 6. Texture Analysis 7. Segmentation 7.1 Classical Methods 7.2 Variational Methods 8. Image Sequence Analysis 8.1 Local Methods 8.2 Variational Methods 9. 3-D Reconstruction 9.1 Camera Geometry 9.2 Stereo 9.3 Shape-from-Shading 10. Object Recognition 10.1 Eigenspace Methods 10.2 Moment Invariances
Assessment / Exams:	• Regular attendance of classes and tutorials. • At least 50% of all possible points from the weekly assignments have to be gained to qualify for the final exam. • Passing the final exam • A re-exam takes place during the last two weeks before the start of lectures in the following semester.
Used Media:	Slides, beamer
Literature:	• R. C. Gonzalez, R. E. Woods: Digital Image Processing. Addison-Wesley, Second Edition, 2002. • K. R. Castleman: Digital Image Processing. Prentice Hall, Englewood Cliffs, 1996. • R. Jain, R. Kasturi, B. G. Schunck: Machine Vision. McGraw-Hill, New York, 1995. • R. Klette, K. Schlüns, A. Koschan: Computer Vision: Three-Dimensional Data from Images. Springer, Singapore, 1998. • E. Trucco, A. Verri: Introductory Techniques for 3-D Computer Vision. Prentice Hill, Upper Saddle River, 1998.

Program of Studies:	Master Program Visual Computing
Name of the module:	Pattern and Speech Recognition
Abbreviation:	
Subtitle	
Modules:	Lecture 2 h (weekly) Tutorial 2 h (weekly)
Semester:	1st-3rd Semester
Responsible lecturer:	Prof. Dr. Dietrich Klakow
Lecturer(s):	Prof. Dr. Dietrich Klakow
Language:	English
Level of the unit / mandatory or not:	Graduate Course / Mandatory elective
Course Type / weekly hours:	Lecture 2 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 15 students
Total workload:	180 h = 56 h of classes and 124 h private study
Credits:	6
Entrance requirements:	Sound knowledge of mathematics as taught in computer science, engineering or physics.
Aims / Competences to be developed:	The students will get to know and understand the basic algorithms of pattern recognition. They will learn how to adopt specific algorithms to specific tasks. In addition, they will acquire knowledge about speech recognition and gain experience in using them.
Content:	• Bayes Classifier • Normal Distribution • Parameter Estimation • Nearest Neighbor Classifier • Gaussian Mixture Models • Decision Trees • Hidden Markov Models • Acoustic Modeling • Adaptation • Search

Assessment / Exams:	Regular attendance of classes and tutorials Presentation of a solution during a tutorial Final exam (30 minutes, oral)
Used Media:	Powerpoint slides, projector, whiteboard
Literature:	• Duda and Hart „Pattern Classification“ • Hastie, Tibshirani and Friedman “The Elements of Statistical Learning” • Xuedong Huang et al. „Spoken Language Processing“

Program of Studies:	Master Program Visual Computing
Name of the module:	Pattern Recognition
Abbreviation:	CS 750 / PR
Subtitle	
Modules:	Lecture 2 h (weekly) Tutorial 1 h (weekly)
Semester:	1st-3rd Semester
Responsible lecturer:	Prof. Dr. Joachim Weickert
Lecturer(s):	Dr. Bernhard Burgeth
Language:	English
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 2 h (weekly) Tutorial 1 h (weekly)
Total workload:	150 h = 50 h classes and 100 h private study
Credits:	5
Entrance requirements:	
Aims / Competences to be developed:	Introduction to the main concepts of kernel-based methods for pattern recognition. The students will learn the mathematical and theoretical foundations as well as suitable algorithms for analysing these data.
Content:	1. Preliminaries from Stochastics 2. Basic Concepts 2.1 Pattern Analysis 2.2 Bayesian Decision Theory 2.3 Maximum Likelihood and Bayesian Parameter Estimator 2.4 Principal Component Analysis and Fisher Discriminants 2.5 Density Estimation 3. Kernel Methods 3.1 Overview 3.2 Properties and Construction 4. Algorithmic Aspects

	4.1 Algorithms in Feature Space 4.2 Algorithms Based on Optimisation 5. Optional: Markov Models
Assessment / Exams:	• Regular attendance of lecture and tutorial • 50% of all possible points from weekly assignments to be eligible for the final exam are needed • Passing the final exam or the re-exam • The re-exam takes place during the last two weeks before the start of lectures in the following semester.
Used Media:	Slides, beamer
Literature:	- Shawe-Taylor and Christiani: Kernel Methods for Pattern Recognition. Cambridge University Press, 2004. - Duda and Hart: Pattern Classification (2nd Ed.). New York, Wiley, 2001. - Wissenschaftliche Artikel

Program of Studies:	Master Program Visual Computing
Name of the module:	Differential Equations in Image Processing and Computer Vision
Abbreviation:	CS 650 / DIC
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1^{st} -3^{rd} Semester
Responsible lecturer:	Prof. Dr. Joachim Weickert
Lecturer(s):	Prof. Dr. Joachim Weickert, Dr. Martin Welk,Dr. Bernhard Burgeth
Language:	English
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) 50% theoretical exercises and 50% practical programming assignments
Total workload:	270 h = 80 h classes and 190 h private study
Credits:	9
Entrance requirements:	
Aims / Competences to be developed:	Many modern techniques in image processing and computer vision make use of methods based on partial differential equations (PDEs) and variational calculus. Moreover, many classical methods may be reinterpreted as approximations of PDE-based techniques. In this course the students will get an in-depth insight into these methods. For each of these techniques, they will learn the basic ideas as well as theoretical and algorithmic aspects. Examples from the fields of medical imaging and computer aided quality control will illustrate the various application possibilities.
Content:	1. Introduction and Overview 2. Linear Diffusion Filtering 2.1 Basic Concepts 2.2 Numerics 2.3 Limitations and Alternatives 3. Nonlinear Isotropic Diffusion Filtering

	3.1 Modeling 3.2 Continuous Theory 3.2 Semidiscete Theory 3.3 Discrete Theory 3.4 Efficient Sequential and Parallel Algorithms 4. Nonlinear Anisotropic Diffusion Filtering 4.1 Modeling 4.2 Continuous Theory 4.3 Discrete Aspects 5. Parameter Selection 6. Variational Methods 6.1 Basic Ideas 6.2 Discrete Aspects 6.3 TV Denoising, Equivalence Results 6.4 Mumford-Shah Segmentation and Diffusion-Reaction Filters 7. Vector- and Matrix-Valued Images 8. Image Sequence Analysis 8.1 Global Methods 8.2 Local Methods 8.3 Combined Local-Global Methods 8.4 Numerical Techniques 9. Continuous-Scale Morphology 9.1 Basic Ideas 9.2 Applications 10. Curvature-Based Morphology 10.1 Basic Ideas 10.2 Applications
Assessment / Exams:	• Regular attendance of lecture and tutorial • 50% of all possible points from weekly assignments to be eligible for the final exam are needed • Passing the final exam or the re-exam • The re-exam takes place during the last two weeks before the start of lectures in the following semester.
Used Media:	Slides, beamer
Literature:	• J. Weickert: Anisotropic Diffusion in Image Processing. Teubner, Stuttgart, 1998. • G. Sapiro: Geometric Partial Differential Equations in Image Analysis. Cambridge University Press, 2001. • G. Aubert and P. Kornprobst: Mathematical Problems in Image Processing: Partial Differential Equations and the Calculus of Variations. Springer, New York, 2002. • Articles from journals and conferences.

Program of Studies:	Master Program Visual Computing
Name of the module:	Differential Geometric Aspects of Image Processing
Abbreviation:	CS 650 / DGAIP
Subtitle	
Modules:	Lecture 2 h (weekly) Tutorial 1 h (weekly)
Semester:	1st -3rd Semester
Responsible lecturer:	Prof. Dr. Joachim Weickert
Lecturer(s):	Dr. Martin Welk
Language:	English
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 2 h (weekly) Tutorial 1 h (weekly)
Total workload:	150 h = 50 h classes and 100 h private study
Credits:	5
Entrance requirements:	
Aims / Competences to be developed:	Specialised course in mathematical image analysis. Participants learn how concepts of differential geometry can be applied in image processing. Mathematical prerequisites which exceed the basic mathematics courses for Visual Computing students are provided within the lecture.
Content:	The course is concerned with modern methods of digital image processing which rely on the differential geometry of curves and surfaces. This includes methods of image enhancement (like smoothing procedures) as well as feature extraction and segmentation (like locating contours using active contour models). The course aims at combining theoretical foundation directly with a variety of applications from the above-mentioned fields; the range of topics extends up to recent research problems. An introduction to the relevant concepts and results from

	differential geometry will be included in the course. Topics include: • curves and surfaces in Euclidean space • level sets • curve and surface evolutions • variational formulations and gradient descents • diffusion of scalar and non-scalar data • diffusion on manifolds • active contours and active regions.
Assessment / Exams:	• Written or oral exam at end of course • A re-exam takes place during the last two weeks before the start of lectures in the following semester.
Used Media:	Slides, beamer
Literature:	• F. Cao, Geometric Curve Evolution and Image Processing. Lecture Notes in Mathematics, vol. 1805, Springer, Berlin 2003. • R. Kimmel, Numerical Geometry of Images. Springer, Berlin 2004. • S. Osher, N. Paragios, eds., Geometric Level Set Methods in Imaging, Vision and Graphics. Springer, Berlin 2003. • G. Sapiro, Geometric Partial Differential Equations and Image Analysis. Cambridge University Press 2001. • Articles from journals and conferences.

Program of Studies:	Master Program Visual Computing
Name of the module:	Probabilistic Methods in Image Processing
Abbreviation:	CS 750 / PMIP
Subtitle	
Modules:	Lecture 2 h (weekly)
Semester:	1st-3rd Semester
Responsible lecturer:	Prof. Dr. Joachim Weickert
Lecturer(s):	Dr. Bernhard Burgeth
Language:	English
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 2 h (weekly)
Total workload:	120 h = 30 h classes and 90 h private study
Credits:	4
Entrance requirements:	
Aims / Competences to be developed:	The students will learn some basic knowledge from probability theory and statistics, and they will learn how to apply these concepts to image processing problems.
Content:	1. Probabilistic Background: 1.1 Probability Measures 1.2 One-dimensional Distributions 1.3 Multivariate Distributions 1.4 Conditional Probability 1.5 Independence 1.6 Random Variables 1.7 Moments 1.8 Characteristic Functions 1.9 Limit Theorems 2. Probabilistic Concepts in Image Processing 2.1 Histogram Based Techniques 2.2 Co-Histograms 2.3 Locally Orderless Images 2.4 Registration, Entropy, and Mutual Information 2.5 Parzen Estimates and Maximum Likelihood

	2.6 PCA and SVD 3. Optional: Introduction to Markov Random Fields
Assessment / Exams:	• Oral exam at the end of the semester • A re-exam takes place during the last two weeks before the start of lectures in the following semester.
Used Media:	Slides, beamer
Literature:	- Krengel, U.: Einführung in die Wahrscheinlichkeitstheorie (7. Aufl.). Braunschweig, Vieweg 2003. - Jacod, J.; Protter, P.: Probability Essentials. Springer, 2000 - Behrends, E.: Introduction to Markov Chains. Braunschweig, Vieweg 2000.

Program of Studies:	Master Program Visual Computing
Name of the module:	Mathematical Morphology in Image Analysis
Abbreviation:	
Subtitle	
Modules:	Lecture 2 h (weekly)
Semester:	1.-3. Semester
Responsible lecturer:	Prof. Dr. Joachim Weickert
Lecturer(s):	Dr. Bernhard Burgeth, Prof. Dr. Joachim Weickert
Language:	English
Level of the unit / obligatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 2 h (weekly)
Total workload:	120 h = 30 h of classes and 90 h private study
Credits:	4
Entrance requirements:	
Aims / Competences to be developed:	The goal of the course is a thorough introduction to mathematical morphology in its classical setting as well as in its modern advances.
Content:	Mathematical Morphology is a well-established and successful methodology for the processing of images. It provides tools to analyse shapes in images by ``probing`` image features with sets or functions. As such mathematical morphology relies on techniques from set and lattice theory, integral geometry and nonlinear partial differential equations. The course introduces the student to the basic morphological operations, beginning with the fundamental operations of dilation and erosion and stretching to morphological derivatives. Strategies of how to concatenate these operators to obtain useful morphological filters for images are discussed. The course also deals with more recent developments: 1. The extension of the morphological operations to data types such as vector or matrix-fields, important for medical imaging

	(i.e. DT-MRI data). 2. Continuous scale morphology where the crucial dilation/erosion process is driven by nonlinear partial differential equations.
Assessment / Exams:	final oral or written exam in the first weeks after the lecturing period; re-exam (oral or written) in the last two weeks before the next lecturing period
Used Media:	Beamer. blackboard
Literature:	P. Soille: Morphological Image Analysis, 2nd edition, Springer, Berlin, 2003 J. Weickert, H. Hagen (Eds.): Visualization and Processing of Tensor Fields. Springer, Berlin, 2006 Relevant articles in this field

Program of Studies:	Master Program Visual Computing
Name of the module:	Computer Graphics II
Abbreviation:	CS 650 / CG II-3D
Subtitle	3D Image Analysis and Synthesis
Modules:	Lecture 2 h (weekly) Tutorial 2 h (weekly)
Semester:	1^{st} -3^{rd} Semester
Responsible lecturer:	Prof. Dr. Hans-Peter Seidel, Dr. Marcus Magnor
Lecturer(s):	Dr. Marcus Magnor, Dr. Volker Blanz
Language:	English
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 2 h (weekly) Tutorial 2 h (weekly)
Total workload:	180 h = 60 h classes and 120 h private study
Credits:	6
Entrance requirements:	
Aims / Competences to be developed:	• Imaging fundamentals • Reconstruction algorithms • Implementation in C/C++ • Rendering from image data
Content:	• Image formation • Photometric and geometric camera calibration • Low-level image processing • 3D scanning • reflection properties • 3d reconstruction, image-based rendering, motion capture
Assessment / Exams:	• Successful completion of at least 50% of the exercises • Oral exam • A re-exam takes place during the last two weeks before the start of lectures in the following semester.

Used Media:	Slides, video, beamer, blackboard
Literature:	Reinhard Klette, Andreas Koshan, Karsten Schins, „Computer Vision“, Vieweg 1996 Richard Hartley and Andrew Zisserman, „Multiple View Geometry in Computer Vision“

Image Synthesis

Program of Studies:	Master Program Visual Computing
Name of the module:	Computer Graphics
Abbreviation:	CS 552 / CG
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1^{st} -3^{rd} Semester / At least once every two years
Responsible lecturer:	Prof. Dr. Philipp Slusallek
Lecturer(s):	Prof. Dr. Philipp Slusallek, Prof. Dr. Hans-Peter Seidel, Dr. Marcus Magnor
Language:	English
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 25 students
Total workload:	270 h = 90 h of classes and 180 h private study
Credits:	9
Entrance requirements:	
Aims / Competences to be developed:	This course provides the theoretical and practical foundation for computer graphics. It gives a wide overview of topics, techniques, and approaches used in various aspects of computer graphics but focuses on image synthesis or rendering. After introducing of physical background and the representations used in graphics it discusses the two basic algorithms for image synthesis: ray tracing and rasterization. In this context we present related topics like texturing, shading, aliasing, sampling, and many more. As part of the practical exercises the students incrementally build their own ray tracing system or hardware-based visualization application. A final rendering competition allows students to implement their favorite advanced algorithm and and use it in a high-quality rendering.
Content:	Fundamentals of digital image synthesis • Physical laws of light transport • Human visual system and perception

	• Colors and Tone-Mapping • Signal processing and anti-aliasing • Materials and reflection models • Geometric modeling • Camera models Ray Tracing • Recursive ray tracing algorithm • Spatial index structures • Sampling approaches • Parallel and distributed algorithms Rasterization and Graphics Hardware • Homogeneous coordinates, transformations • Hardware architectures • Rendering pipeline • Shader programming and languages • OpenGL
Assessment / Exams:	• Sucessful completion of at least 50% of the exercises • Sucessful participation in rendering competition • Final written exam • Final grade determined by result of the exam and the rendering competition • A re-exam takes place during the last two weeks before the start of lectures in the following semester.
Used Media:	Electronic slides, examples, live presentations Practical excersises on a 3D graphics PC Development of an individual extension to ray tracing and/or OpenGL algorithms
Literature:	• Alan Watt, 3D Computer Graphics, Addison-Wesley, 1999 • James Foley, AndriesVan Dam, et al., Computer Graphics : Principles and Practice, 2. Edition, Addison-Wesley, 1995 • Andrew Glassner, Principles of Digital Image Synthesis, 2 Volumes, Morgan Kaufman, 1996 • Peter Shirley, Realistic Ray-Tracing, AK Peters • Andrew Woo, et al., OpenGL Programming Guide, 3. Edition, Addison-Wesley, 1999 • Randima Fernando, GPU Gems, Addison-Wesley, 2004

Program of Studies:	Master Program Visual Computing
Name of the module:	Computer Graphics II
Abbreviation:	CS 650 / CGII-RIS
Subtitle	Realistic Image Synthesis
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1st -3rd Semester
Responsible lecturer:	Prof. Dr. Philipp Slusallek
Lecturer(s):	Prof. Dr. Philipp Slusallek
Language:	English
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Total workload:	270 h = 80 h classes and 190 h private study
Credits:	9
Entrance requirements:	
Aims / Competences to be developed:	At the core of computer graphics is the requirement to render highly realistic and often even physically accurate images of virtual 3D scenes. In this lecture students will learn about physically-based simulation techniques to compute the distribution of light in even complex environment. After this course students should be able to build their own highly realistic but also efficient rendering system.
Content:	• Rendering and Radiosity Equation, Finite Elements • Radiosity • Monte Carlo Techniques • Direct Illumination, Importance Sampling • BRDF, Inversion Methods • Distribution Ray Tracing and Path Tracing • Theory of Variance Reduction • Bidirectional Path Tracing, Instant Radiosity • Density Estimation Methods • Photon Mapping • Rendering of Animations • Motion Blur, Temporal Filtering

	• Interactive Global Illumination • Hardware Rendering Basics • Advanced Hardware Rendering • Measurements of BRDFs and Light Sources • Relighting • Tone Mapping, Perception
Assessment / Exams:	• Theoretical and practical exercises (50% requirement for final exam) • Final oral exam • A re-exam takes place during the last two weeks before the start of lectures in the following semester.
Used Media:	Electronic slides, recent papers, live demos, etc. Example programs are provided as starting points for advanced algorithms
Literature:	Michael Cohen, John Wallace, Radiosity and Realistic Image Synthesis, Academic Press, 1993. Andrew Glassner, Principles of Digital Image Synthesis, 2 Bände, Morgan Kaufman, 1996. Andrew Glassner, An Introduction to Ray Tracing, Academic Press, 1989. James Foley, AndriesVan Dam, et al., Computer Graphics: Principles and Practice, 2. Ausgabe, Addison-Wesley, 1995.

Program of Studies:	Master Program Visual Computing
Name of the module:	Scientific Visualization
Abbreviation:	CS 650 / SCV
Subtitle	
Modules:	Lecture 2 h (weekly) Tutorial 4 h (weekly)
Semester:	1st -3rd Semester
Responsible lecturer:	Prof. Dr. Hans-Peter Seidel
Lecturer(s):	Dr. Holger Theisel
Language:	English
Level of the unit / mandatory or not:	Graduate course/ Mandatory Elective
Course Type / weekly hours:	Lecture 2 h (weekly) Tutorial 4 h (weekly)
Total workload:	270 h = 90 h classes and 180 h private study
Credits:	9
Entrance requirements:	None, but some background from the Computer Graphics 1 course is helpful.
Aims / Competences to be developed:	Nowadays huge amounts of data are constantly created in various kinds of applications like medicine, engineering, science and industry. Due to the increasing size and complexity of the data, an effective data analysis is still a challenge. One approach to do so is to create a *visualization* in such a way that important properties and correlations of the data become visible in an intuitive way. The lecture gives an overview of the most important concepts and algorithms in data visualization. Advances and limitations of data visualization are discussed. In particular the lecture focuses on four data classes: multivariate data (spatial and temporal), volume data, flow data, and tensor data.
Content:	• Introduction • Data Description and Selection • Mapping • Visualization of Multiparameter Data • Volume Visualization

	• Flow Visualization • Tensor Field Visualization • Information Visualization • Visualization Systems
Assessment / Exams:	• Amira exploration of unknown data set • Oral Exam at the end of the course
Used Media:	Electronic slides, recent papers, live demos, etc.
Literature:	Script and up to date list at the beginning of the course

Program of Studies:	Master Program Visual Computing
Name of the module:	Multimedia
Abbreviation:	CS 650 / MM
Subtitle	
Modules:	Lecture 2 h (weekly) Tutorial 2 h (weekly)
Semester:	1^{st} -3^{rd} Semester
Responsible lecturer:	Prof. Dr. Philipp Slusallek
Lecturer(s):	Prof. Dr. Philipp Slusallek, Marco Lohse
Language:	English
Level of the unit / mandatory or not:	Graduate course/ Mandatory Elective
Course Type / weekly hours:	Lecture 2 h (weekly) Tutorial 2 h (weekly)
Total workload:	180 h = 60 h classes and 120 h private study
Credits:	6
Entrance requirements:	None, but some background from the Computer Graphics 1 course is helpful.
Aims / Competences to be developed:	Digital media has become an integral part of today's desktop computers and mobile systems allowing us to capture, create, process, edit, render audio and video in realtime. This lecture will present the theoretical, technical, and practical background of handling media streams in a computer. Of particular interest is middleware that allows for creating distributed digital media applications that can transparently use any devices or processing module available in a network. The course is based on the Network-Multimedia-System (NMM) developed in Saarbrücken. After the course students should understand the theoretical, technological, and practical issues and challenges of digital media systems. They should be able to create their own media processing modules for NMM or similar systems.
Content:	• Digital media devices and their characteristics • Perception issues

	• Types and formats of multimedia streams • Signal processing • Audio and video compression techniques • Local and distributed synchronization • Network protocols and technology for streaming media • Middleware for digital media • Applications
Assessment / Exams:	• Theoretical and practical exercises (50% requirement for final exam) • A final oral exam • The final grade depend equally on the excercises and the final exam • A re-exam takes place during the last two weeks before the start of lectures in the following semester.
Used Media:	Electronic slides, recent papers, live demos, etc. Example programs are provided as starting points for advanced algorithms
Literature:	Steinmetz, Ralf: *Multimedia-Technologie. Grundlagen, Komponenten und Systeme*; Dritte, überarbeitete Auflage, Springer, Berlin; Heidelberg; New York (2000). Foley, James D. and van Dam, Andries and Feiner, Steven K. and Hughes, John F.: *Computer Graphics: Principles and Practice*, second edition in C. The Systems Programming Series. Addison-Wesley, Bonn;Amsterdam;Tokyo (1996).

Program of Studies:	Master Program Visual Computing
Name of the module:	Computer Graphics II
Abbreviation:	CS 650 / CG II-3D
Subtitle	3D Image Analysis and Synthesis
Modules:	Lecture 2 h (weekly) Tutorial 2 h (weekly)
Semester:	1^{st} -3^{rd} Semester
Responsible lecturer:	Prof. Dr. Hans-Peter Seidel, Dr. Marcus Magnor
Lecturer(s):	Dr. Marcus Magnor, Dr. Volker Blanz
Language:	English
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 2 h (weekly) Tutorial 2 h (weekly)
Total workload:	180 h = 60 h classes and 120 h private study
Credits:	6
Entrance requirements:	
Aims / Competences to be developed:	• Imaging fundamentals • Reconstruction algorithms • Implementation in C/C++ • Rendering from image data
Content:	• Image formation • Photometric and geometric camera calibration • Low-level image processing • 3D scanning • reflection properties • 3d reconstruction, image-based rendering, motion capture
Assessment / Exams:	• Sucessful completion of at least 50% of the exercises • Oral exam • A re-exam takes place during the last two weeks before the start of lectures in the following semester.

Used Media:	Slides, video, beamer, blackboard
Literature:	Reinhard Klette, Andreas Koshan, Karsten Schins, „Computer Vision“, Vieweg 1996 Richard Hartley and Andrew Zisserman, „Multiple View Geometry in Computer Vision“

Seminar

Program of Studies:	Master Program Visual Computing
Name of the module:	Seminar
Abbreviation:	VC 500
Subtitle	Changing Topics
Modules:	Seminar 3 h (weekly)
Semester:	1st - 3rd Semester / offered each semester
Responsible lecturer:	Dean of studies and relevant Professor
Lecturer(s):	Professors of the Department
Language:	English
Level of the unit / mandatory or not:	Graduate course/ Mandatory Elective
Course Type / weekly hours:	Seminar 3 h (weekly) / groups of up to 25 students
Total workload:	240 h = 80 h classes und 160 h private study
Credits:	8
Entrance requirements:	Basic knowledge in the field of visual computing under focus in the respective seminar.
Aims / Competences to be developed:	At the end of the course students have gained a thorough knowledge of current or foundational aspects of a specific area in visual computing. They attained competences in independently investigating, classifiying, summarizing, discussing, criticizing scientifc issues and presenting scientific findings.
Content:	Practical exercising of • Reflecting on scientific work, • Analyzing and assessing scientific papers • Composing scientific abstracts • Discussing scientific work in a peer group • Developing common standars for scientific work • Presentation techniques Specific focus according to the individual topic of the seminar.

	Typical course progression: • Preparatory meetings to guide selection of individual topics • Repetitive meetings with discussions of selected contributions • Talk and elaboration on one of the contributions
Assessment / Exams:	• Contributions to discussions • Thematic talk • Written elaboration • Final oral examination on the entire scientific area spanned by the seminar
Used Media:	Discussions during class Talks based on slides
Literature:	According to the topic

Related Fields

Program of Studies:	Master Program Visual Computing
Name of the module:	Information Retrieval and Data Mining
Abbreviation:	CS 555 / IRDM
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1^{st} -3^{rd} Semester / At least once every two years
Responsible lecturer:	Prof. Dr. Gerhard Weikum
Lecturer(s):	Prof. Dr. Gerhard Weikum
Language:	English
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 25 students
Total workload:	270 h = 90 h of classes and 180 h private study
Credits:	9
Entrance requirements:	
Aims / Competences to be developed:	The lecture teaches mathematical models and algorithms that form the basis for search engines for the Web, intranets, and digital libraries and for data mining and analysis tools.
Content:	Information Retrieval and Data Mining are technologies for searching, analyzing and automatically organizing text documents, multi-media documents, and structured or semistructured data. The course teaches mathematical models and algorithms that form the basis for search engines for the Web, intranets, and digital libraries and for data mining and analysis tools. The fundamentals are models and methods from linear algebra and regression (e.g. singular-value decomposition) as well as probability theory and statistics (e.g. Bayesian networks and Markov chains). The exercises include practical tasks for the

	implementation of a simple search engine in Java.
Assessment / Exams:	• Regular attendance of classes and tutorials • Passing 2 of 3 written exams (midterm, final and re-exam) • Presentation of a solution during a tutorial (at least once) • For each additional presentation up to 3 bonus points can be gained • Passing the practical exercises (teams of up to two students) • Up to 3 bonus points can be gained fort he overall quality of the solutions • The re-exam takes place during the last two weeks before the start of lectures in the following semester.
Used Media:	Slides, beamer, blackboard
Literature:	**Information Retrieval** *C.D. Manning, H. Schütze:* Foundations of Statistical Natural Language Processing, MIT Press, 1999 *S. Chakrabarti*: Mining the Web: Analysis of Hypertext and Semistructured Data, Morgan Kaufmann, 2002 *R. Baeza-Yates, B. Ribeiro-Neto*: Modern Information Retrieval, Addison-Wesley, 1999. *N. Fuhr:* Information Retrieval, Skriptum zur Vorlesung im SS 2002, Uni Dortmund. **Data Mining** *J. Han, M. Kamber*: Data Mining: Concepts and Techniques, Morgan Kaufmann, 2000 *R.O. Duda, P.E. Hart, D.G. Stork*: Pattern Classification, John Wiley & Sons, 2001 **Java** Go To Java 2 Thinking in Java

Program of Studies:	Master Program Visual Computing
Name of the module:	Artificial Intelligence
Abbreviation:	CS 556 / AI
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1st -3rd Semester / At least once every two years
Responsible lecturer:	Prof. Dr. Wolfgang Wahlster
Lecturer(s):	Prof. Dr. Wolfgang Wahlster, Prof. Dr. Jörg Siekmann, Dr. Serge Autexier
Language:	English
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 25 students
Total workload:	270 h = 90 h of classes and 180 h private study
Credits:	9
Entrance requirements:	
Aims / Competences to be developed:	Knowledge about the fundamentals of artificial intelligence
Content:	Problem-solving: • Uninformed- and informed search procedures • Adversarial search • Knowledge and reasoning: • First-order logic, Inference in first-order logic • Knowledge representation Planning: • Planning • Planning and acting in the real world Uncertain knowledge and reasoning: • Uncertainty • Probabilistic reasoning

	• Simple & complex decisions Learning: • Learning from observations • Knowledge in learning • Statistical learning methods • Reinforcement learning Communicating, perceiving, and acting: • Communication • Natural language processing • Perception
Assessment / Exams:	• Regular attendance of classes and tutorials • Solving of weekly assignments • Passing the final written exam • A re-exam takes place during the last two weeks before the start of lectures in the following semester.
Used Media:	Slides, beamer, blackboard during classes, printouts and assignments at the WWW, practical assignments (Computer)
Literature:	An updated list of used literature will be issued at the beginning of the semester. S. Russell, P. Norvig: Artificial Intelligence – A Modern Approach (2nd Edition), Prentice Hall Series in AI,

Program of Studies:	Master Program Visual Computing
Name of the module:	Telecommunications I
Abbreviation:	CS 560 / TC I
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1^{st} -3^{rd} Semester / At least once every two years
Responsible lecturer:	Prof. Dr.-Ing. Thorsten Herfet
Lecturer(s):	Lecture: Prof. Dr.-Ing. Thorsten Herfet Tutorial task sheets: Muhammad-Rafey Jameel, M.Sc. Tutorial: Karim Helwani (Student Assistant)
Language:	English
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 25 students
Total workload:	270 h = 80 h of classes and 190 h private study
Credits:	9
Entrance requirements:	"Digital Transmission and Signal Processing" is a graduate course and requires a solid foundation of mathematics (differential and integral calculus) and probability theory. The course will, however, refresh those areas necessary for telecommunications.
Aims / Competences to be developed:	Digital Signal Transmission and Signal Processing refreshes the foundation that you have laid in "Signals and Systems / Signale und Systeme". We will, however, include the respective basics so that ***the various facettes of your undergraduate studies*** (Bachelor in Computer Science, Vordiplom Computer und Kommunikationstechnik, Elektrotechnik oder Mechatronik) ***and graduate studies*** (Master in Visual Computing, Diplom Ingenieur Computer und Kommunikationstechnik oder Mechatronik) ***will be payed respect to***.
Content:	As the basic principle the course will give an introduction into the various building blocks that modern telecommunication systems do incorporate. Sources, sinks, source and channel coding,

	modulation and multiplexing are the major keywords but we will also deal with dedicated pieces like A/D- and D/A-converters and quantizers in a little bit more depth. The course will refresh the basic transformations (Fourier, Laplace) that give access to system analysis in the frequency domain, it will introduce derived transoformations (z, Hilbert) for the anylysis of discrete systems and modulation schemes and it will briefly introduce algebra on finite fields to systematicly deal with error correction schemes that play an important role in modern communication systems.
Assessment / Exams:	Regular attendance of classes and tutorials Passing the final exam Oral exam directly succeeding the course. Eligibility: Weekly excersises / task sheets, grouped into two blocks corresponding to first and second half of the lecture. Students must provide min. 50% grade in each of the two blocks to be eligible for the exam.
Used Media:	Lecture Notes (OHP), PPT Slides, List of Potentially Asked Questions
Literature:	Literature: John G. Proakis, Masoud Salehi: "Communication Systems Engineering 2nd Edition", Prentice Hall, 2002 Claude E. Shannon, Warren Weaver: "The Mathematical Theory of Communication", University of Illinois Press, 1963

Program of Studies:	Master Program Visual Computing
Name of the module:	Telecommunications II
Abbreviation:	CS 650 / TC II
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1st -3rd Semester
Responsible lecturer:	Prof. Dr.-Ing. Thorsten Herfet
Lecturer(s):	Lecture: Prof. Dr.-Ing. Thorsten Herfet Tutorial task sheets: Muhammad-Rafey Jameel, M.Sc. Tutorial: Karim Helwani (Student Assistant)
Language:	English
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 25 students
Total workload:	270 h = 80 h of classes and 190 h private study
Credits:	9
Entrance requirements:	Solid foundation of mathematics (differential and integral calculus) and probability theory. The course will build on the mathematical concepts and tools taught in TC I while trying to enable everyone to follow and to fill gaps by an accelerated study of the accompanying literature. "Signals and Systems" as well as "TC I - Digital Transmission and Signal Processing" are strongly recommended but not required.
Aims / Competences to be developed:	TC II will deepen the students' knowledge on modern communications systems and will focus on wireless systems. Since from a telecommunications perspective the combination of audio/visual data – meaning inherently high data rate and putting high requirements on the realtime capabilities of the underlying network – and wireless transmission – that is unreliable and highly dynamic with respect to the channel characteristics and its capacity – is the most demanding application domain.
Content:	As the basic principle the course will study and introduce the

	building blocks of wireless communication systems. Multiple access schemes like TDMA, FDMA, CDMA and SDMA are introduced, antennas and propagation incl. link budget calculations are dealt with and more advanced channel models like MIMO are investigated. Modulation and error correction technologies presented in Telecommunications I will be expanded by e.g. turbo coding and receiver architectures like RAKE and BLAST will be introduced. A noticeable portion of the lecture will present existing and future wireless networks and their extensions for audio/visual data. Examples include 802.11 (with the TGe Quality of Service extensions), 802.16a and the terrestrial DVB system (DVB-T, DVB-H).
Assessment / Exams:	Regular attendance of classes and tutorials Passing the final exam Oral exam directly succeeding the course. Eligibility: Weekly excersises / task sheets, grouped into two blocks corresponding to first and second half of the lecture. Students must provide min. 50% grade in each of the two blocks to be eligible for the exam.
Used Media:	Lecture Notes (OHP), PPT Slides, List of Potentially Asked Questions
Literature:	Literature: Foreground (TC II) Aura Ganz, Zivi Ganz, Kitty Wongthavarawat: "Multimedia Wireless Networks – Technologies, Standards, and QoS", Prentice Hall, 2004 Simon Haykin, Michael Moher: "Modern Wireless Communications", Prentice Hall, 2005 Ulrich Reimers: "Digital Video Broadcasting – The Family of International Standards for Digital Video Broadcasting", Springer, 2005 William Stallings: "Wireless Communications & Networks 2nd Edition", Prentice Hall, 2005 Background (TC I) John G. Proakis, Masoud Salehi: "Communication Systems Engineering 2nd Edition", Prentice Hall, 2002 Claude E. Shannon, Warren Weaver: "The Mathematical Theory of Communication", University of Illinois Press, 1963

Supplementary Modules on Prerequisites

Mathematics

Program of Studies:	Master Program Visual Computing
Name of the module:	Praktische Mathematik 1
Abbreviation:	
Subtitle	
	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1st-3rd Semester
Responsible lecturer:	Prof. Dr. S. Rjasanow
Lecturer(s):	Prof. Dr. S. Rjasanow
Language:	German
Level of the unit / obligatory or not:	Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Total workload:	270 h = 90 h of classes and 180 h private study
Credits:	9
Entrance requirements:	
Aims / Competences to be developed:	Das Ziel ist der Erwerb grundlegender Begriffe, Methoden und Techniken der Praktischen Mathematik der Linearen Algebra und der Analysis.
Content:	- Fehlerrechnung - Lineare Gleichungssysteme - Eigenwertprobleme - Interpolation - Numerische Integration - Nichtlineare Gleichungssysteme
Assessment / Exams:	Kreditpunkte: erfolgreicher Besuch der Übungen und bestandene Klausur,

	Note: schriftliche Prüfung
Used Media:	Blackboard
Literature:	Script und aktuelle Liste zu Semesterbeginn

Program of Studies:	Master Program Visual Computing
Name of the module:	Theorie und Numerik Gewöhnlicher Differentialgleichungen
Abbreviation:	
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1st-3rd Semester
Responsible lecturer:	Prof. Dr. S. Rjasanow
Lecturer(s):	Prof. Dr. S. Rjasanow
Language:	German
Level of the unit / obligatory or not:	Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Total workload:	270 h = 90 h of classes and 180 h private study
Credits:	9
Entrance requirements:	
Aims / Competences to be developed:	Das Ziel ist der Erwerb der Methoden und Techniken der analytischen und numerischen Lösung von Gewöhnlichen Differentialgleichungen.
Content:	- Beispiele - Spezielle Differentialgleichungen - Spezielle Differentialgleichungen 2. Ordnung - Die Laplace-Transformation - Existenztheorie - Differentialgleichungssysteme und Differentialgleichungen höherer Ordnung - Runge-Kutta-Methoden - Mehrschrittverfahren - Integration steifer Differentialgleichungen - Randwertprobleme - Einführung in die Finite-Elemente-Methode
Assessment / Exams:	Kreditpunkte: erfolgreicher Besuch der Übungen und bestandene Klausur,

	Note: schriftliche Prüfung
Used Media:	Blackboard
Literature:	Script und aktuelle Liste zu Semesterbeginn

Program of Studies:	Master Program Visual Computing
Name of the module:	Stochastik
Abbreviation:	
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1st-3rd Semester
Responsible lecturer:	Prof. Dr. Michael Kohler
Lecturer(s):	Prof. Dr. Michael Kohler
Language:	German
Level of the unit / obligatory or not:	Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Total workload:	270 h = 90 h of classes and 180 h of private study
Credits:	9
Entrance requirements:	
Aims / Competences to be developed:	Mathematical foundation of probability theory
Content:	Probability spaces, theorem of Caratheodory, distribution functions, measurable functions and random variables, integral in general measurable spaces and expectations, theorem of Lebesque, Levi and Fatou, product measures and independence of random variables, theorem of Fubini.
Assessment / Exams:	• Regular attendance of tutorials • At least 50 % of the maximal number of points for the solutions of the exercises • Passing of a final exam
Used Media:	Blackboard
Literature:	• H. Bauer: Maßtheorie und Integrationstheorie. De Gruyter, 1992 • H. Bauer: Wahrscheinlichkeitstheorie. De Gruyter, 2002

Program of Studies:	Master Program Visual Computing
Name of the module:	Numerical Methods for Partial Differential Equations
Abbreviation:	
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1st-3rd Semester
Responsible lecturer:	Prof. Dr. Volker John
Lecturer(s):	Prof. Dr. Volker John
Language:	English
Level of the unit / obligatory or not:	Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 20 students
Total workload:	270 h = 90 h of classes and 180 h of private study
Credits:	9
Entrance requirements:	
Aims / Competences to be developed:	The classes introduce numerical methods for solving partial differential equations, present analytical results and discuss implementational aspects. The implementation and numerical studies of the methods will be an important topic in the tutorials.
Content:	• finite difference methods for elliptic and parabolic problems • introduction to Sobolev spaces • Ritz´ method • standard finite element methods, interpolation into finite element spaces • advanced finite element methods: nonconforming finite elements, a posteriori error estimation, adaptive finite elements • mixed finite element methods for equations from computational fluid dynamics • solvers for large linear systems of equations
Assessment / Exams:	• regular attendance of classes and tutorials • passing 1 of 2 written or oral exams (final and re-exam) • presentation of a solution during a tutorial at least once

	• successful implementation of a more involved method at least once (teams up to two students)
Used Media:	blackboard, beamer
Literature:	finite difference and finite element methods • D. Braess. Finite Elements. Theory, Fast Solvers and Applications in Solid Mechanics. Cambridge University Press 2001 • P. Knabner, L. Angermann. Numerical Methods for Elliptic and Parabolic Partial Differential Equations. Springer-Verlag, New York 2003 • S.C. Brenner, L.R. Scott. The Mathematical Theory of Finite Element Methods. Springer-Verlag, New York 1994 • P. Solin. Partial Differential Equations and the Finite Element Method. Wiley 2005 solvers for large linear systems • A. Greenbaum. Iterative Methods for Solving Linear Systems. SIAM, Philadelphia 1997 • Y. Saad. Iterative Methods for Sparse Linear Systems. SIAM, Philadelphia 2003

Program of Studies:	Master Program Visual Computing
Name of the module:	Integral Equations
Abbreviation:	
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1.-3. Semester
Responsible lecturer:	Prof. Dr. Alfred K. Louis
Lecturer(s):	Prof. Dr. Alfred K. Louis
Language:	German
Level of the unit / obligatory or not:	Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Total workload:	270 h = 90 h of classes and 180 h of private study
Credits:	9
Entrance requirements:	
Aims / Competences to be developed:	The lecture teaches the mathematics of integral equations of the first and second kind as well as numerical methods.
Content:	Classification of integral equations Operator theory, Fredholm theory, Fredholm and Volterra equations Solution methods for equations of the second kind: projection methods, Nystrom method, fast solution of the discrete problems, multigrid methods Singular integral equations Equations of the first kind, regularization methods Applications
Assessment / Exams:	Regular attendance of classes and tutorials Passing of examination (final, re-exam)
Used Media:	Blackboard, Beamer

Literature:	Kress: Linear Integral Equations, Springer 1989 Hackbusch: Integralgleichungen, Teubner 1989 Engl: Integralgleichungen, Springer 1997

Program of Studies:	Master Program Visual Computing
Name of the module:	Calculus of Variations
Abbreviation:	
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1rd-3rd Semester
Responsible lecturer:	Prof. Dr. Martin Fuchs
Lecturer(s):	Prof. Dr. Martin Fuchs
Language:	English
Level of the unit / obligatory or not:	Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 25 students
Total workload:	270h = 90h classes and 180h self study
Credits:	9
Entrance requirements:	
Aims / Competences to be developed:	The lecture presents an introduction into the basic problems of the Calculus of Variations such as the questions of existence and regularity of solutions for multiple integrals
Content:	Many problems in mathematical physics (e.g. nonlinear elasticity, perfect plasticity, stationary flows of generalized Newtonian fluids) or geometry (e.g. minimal surfaces, surfaces of prescribed mean curvature, partition problems) immediately lead to minimization problems for multiple integrals under various boundary and/or topological conditions. In the first part of the course we use the direct method in order to establish the existence of minimizers in appropriate classes of generalized functions. More precisely, we introduce the Sobolev-classes and the space of functions of bounded variation which have nice compactness properties and for which lower semicontinuity theorems with respect to the weak topologies can be established for various energy functionals provided that they share certain convexity and growth conditions. The minimizers constructed in this setting a priori have no

	differentiability properties, and in the second part we describe the basics of a regularity theory showing that scalar minimizers are in fact as smooth as the data, whereas for vector valued minimizers the occurrence of singularities in general can not be excluded. This is typical for “material instabilities” such as the formation of holes and cracks.
Assessment / Exams:	Regular attendance of classes and tutorials Passing 2 of 3 written exams (midterm, final and re-exam) Presentation of a solution during a tutorial (at least once)
Used Media:	blackboard
Literature:	• *B. Dacorogna*, Direct Methods In The Calculus of Variations, Springer Verlag 1988 • *M. Giaquinta*, Multiple Integrals In The Calculus of Variations And Nonlinear Elliptic Systems, Princeton University Press 1983 • *M. Fuchs,* Topics In The Calculus Of Variations, Vieweg Verlag 1994 • M. Fuchs, G. Seregin, Variational Methods For Problems From Plasticity Theory And For Generalized Newtoniann Fluids, Springer Verlag 2000

Program of Studies:	Master Program Visual Computing
Name of the module:	Differential Geometry of Curves and Surfaces
Abbreviation:	
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1st-3rd Semester
Responsible lecturer:	P.D. Michael Bildhauer
Lecturer(s):	P.D. Michael Bildhauer
Language:	English
Level of the unit / obligatory or not:	Elective
Course Type / weekly hours:	Lecture 4h (weekly) Tutorial 2h (weekly) Tutorial in groups of up to 25 students
Total workload:	270 h = 90h of classes and 180 h private study
Credits:	9
Entrance requirements:	
Aims / Competences to be developed:	The students should be become familiar with the main geometric ideas of curves and surfaces. Moreover, the course teaches how to realise these ideas analytically.
Content:	In the first part parametrized curves are discussed, in particular the fundamental theorem of the local theory of curves. Next the concept of regular surfaces is introduced together with the first fundamental form. The main topic of the third part is the geometry of the Gauss Map. Here several notions of curvature will be presented together with interesting applications such as minimal surfaces. Finally the intrinsic geometry of surfaces will be studied. The main issues are: conformal maps, geodesics and the theorem of Gauss-Bonnet.
Assessment / Exams:	Regular attendance of classes and tutorial, presentation of a solution during a tutorial (at least once), passing the practical exercises (teams of up to two students), written exam at the end of the semester, re-exam during the last two weeks before the start of lectures in the following semester.

Used Media:	Slides, beamer, blackboard.
Literature:	DoCarmo, M., Differential geometry of curves and surfaces., Prentice-Hall, 1976. Dierkes, U., Hildebrandt, S., Küster, A., Wohlrab, O., Minimal surfaces. Springer, 1992. Jost, J.,Differentialgeometrie und Minimalflächen. Springer1994.

Program of Studies:	Master Program Visual Computing
Name of the module:	Partial Differential Equations
Abbreviation:	
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1st-3rd Semester
Responsible lecturer:	Prof. Dr. Martin Fuchs
Lecturer(s):	Prof. Dr. Martin Fuchs
Language:	English
Level of the unit / obligatory or not:	Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 25 students
Total workload:	270 h = 90h of classes and 180 h private study
Credits:	9
Entrance requirements:	
Aims / Competences to be developed:	The lecture provides a systematic development of the general theory of second order quasilinear elliptic and parabolic partial differential equations and of the linear theory required in the process.
Content:	Starting from prominent examples, we first present the standard classification schemes for partial differential equations (PDE), present some elementary approaches for linear PDE's via explicit solutions and illustrate on the contrary certain nonlinear phenomena. After this the lecture gives a systematic study of linear elliptic PDE's of second order proving the existence (and the uniqueness) of solutions for the Dirichlet boundary value problem. For linear parabolic PDE's of second order the corresponding initial boundary value problem is investigated in detail. This material then is used to discuss quasilinear problems. The course finishes with a brief introduction into nonlinear PDE's of second order such as the minimal surface equation and the Navier-Stokes system.

Assessment / Exams:	• Regular attendance of classes and tutorials • Passing 2 of 3 written exams (midterm, final and re-exam) • Presentation of a solution during a tutorial (at least once)
Used Media:	blackboard
Literature:	• *J. Jost,* Partielle Differentialgleichungen, Springer Verlag 1998 • *D. Gilbarg, N.S. Trudinger*, Elliptic Partial Differential Equations of second order, Springer Verlag 1983 • *F. John*, Partial Differential Equations. Springer Verlag 1982 • *A. Friedman,* Partial Differential Equations of Parabolic Type, Prentice-Hall 1964

Program of Studies:	Master Program Visual Computing
Name of the module:	Inverse Problems
Abbreviation:	
Subtitle	
Modules:	Lecture 4h (weekly) Tutorial 2h (weekly)
Semester:	1.-3. Semester
Responsible lecturer:	Prof. Dr. Alfred K. Louis
Lecturer(s):	Prof. Dr. Alfred K. Louis
Language:	German
Level of the unit / obligatory or not:	Elective
Course Type / weekly hours:	Lecture 4h (weekly) Tutorial 2h (weekly)
Total workload:	270 h = 90h of classes and 180 h private study
Credits:	9
Entrance requirements:	
Aims / Competences to be developed:	The lecture teaches the mathematical background and numerical algorithms for inverse problems, examples from several fields are presented.
Content:	Mathematical Background: compact operators, spectral theory Regularization methods: approximate inverse, Tikhonov - Phillips regularization, iterative methods, truncated singular value decomposition optimal regularization and parameter selection Numerical realization Nonlinear problems Examples in medical imaging
Assessment / Exams:	Regular attendance of classes and tutorials Passing of examination (final, re-exam)
Used Media:	Blackboard, beamer
Literature:	Louis: Inverse und schlecht gestellte Probleme, Teubner, 1989

	Engl, Hanke, Neubauer: Regularization of Inverse Problems, Kluwe, 2000 Hansen: Rank-deficient and discrete ill-posed problems, SIAM, 1998

Program of Studies:	Master Program Visual Computing
Name of the module:	
Abbreviation:	
Subtitle	
Modules:	Lecture 4h (weekly) Tutorial 2h (weekly)
Semester:	1.-3. Semester
Responsible lecturer:	Prof. Dr. Alfred K. Louis
Lecturer(s):	Prof. Dr. Alfred K. Louis
Language:	German
Level of the unit / obligatory or not:	Elective
Course Type / weekly hours:	Lecture 4h (weekly) Tutorial 2h (weekly)
Total workload:	270 h = 90h of classes and 180 h private study
Credits:	9
Entrance requirements:	
Aims / Competences to be developed:	The lecture teaches the mathematical background and numerical algorithms for inverse problems, examples from several fields are presented.
Content:	Analysis of Fourier, Laplace, Hankel, Mellin, Radon and Wavelet transform Numerical realization and fast algorithms Application to partial differential equations, signal- and image processing.
Assessment / Exams:	Regular attendance of classes and tutorials Passing of examination (final, re-exam)
Used Media:	Blackboard, beamer
Literature:	Hochstadt: Integral Equations, Wiley, 1973 Terras: Harmonic analysis on symmetric spaces and applications, 1985 Stoer-Bulirsch: Introduction to numerical analysis, Springer, 1980

	Louis, Maaß, Rieder: Wavelets: Theory and Applications, Wiley, 1997

Computer Science

Program of Studies:	Master Program Visual Computing
Name of the module:	Programmierung 1
Abbreviation:	CS 120 / P1
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1st -3rd Semester / every winter semester
Responsible lecturer:	Prof. Dr. Gert Smolka
Lecturer(s):	Prof. Dr. Gert Smolka, Prof. Dr. Andreas Podelski, Prof. Dr.-Ing. Holger Hermanns
Language:	German
Level of the unit / mandatory or not:	Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 25 students
Total workload:	270 h = 90 h of classes and 180 h private study
Credits:	9
Entrance requirements:	-
Aims / Competences to be developed:	• köcherstufige, getypte funktionale Programmierung anwenden können • Verständnis rekursiver Datenstrukturen und Algorithmen, Zusammenhänge mit Mengenlehre • Korrektheit beweisen und Laufzeit abschätzen • Typabstraktion und Modularisierung verstehen • Struktur von Programmiersprachen verstehen • einfache Programmiersprachen formal beschreiben können • einfache Programmiersprachen implementieren können • anwendungsnahe Rechenmodelle mit maschinennahen Rechenmodellen realisieren können • Praktische Programmiererfahrung, Routine im Umgang mit Interpretern und Übersetzern

Content:	• Funktionale Programmierung • Algorithmen und Datenstrukturen (Listen, Bäume, Graphen; Korrektheitsbeweise; asymptotische Laufzeit) • Typabstraktion und Module • Programmieren mit Ausnahmen • Datenstrukturen mit Zustand • Struktur von Programmiersprachen (konkrete und abstrakte Syntax, statische und dynamische Syntax) • Realisierung von Programmiersprachen (Interpreter, virtuelle Maschinen, Übersetzer)
Assessment / Exams:	• zwei Klausuren (Mitte und Ende der Vorlesungszeit) • Die Note wird aus den Klausuren gemittelt und kann durch Leistungen in den Übungen verbessert werden. • Eine Nachklausur findet innerhalb der letzten beiden Wochen vor Vorlesungsbeginn des Folgesemesters statt.
Used Media:	Tafelvortrag, Papier (Script und Übungsblätter) , Übungen am Computer
Literature:	Skript zur Vorlesung; siehe auch Literaturliste vom WS 02/03: http://www.ps.uni-sb.de/courses/prog-ws02/literatur.html

Program of Studies:	Master Program Visual Computing
Name of the module:	Programmierung 2
Abbreviation:	CS 220 / P2
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1st -3rd Semester / every summer semester
Responsible lecturer:	Prof. Dr. Hans-Peter Lenhof,
Lecturer(s):	Prof. Dr. Hans-Peter Lenhof, Prof. Dr. Bernd Finkbeiner, Prof. Dr. Raimund Seidel
Language:	German
Level of the unit / mandatory or not:	Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 25 students
Total workload:	270 h = 90 h of classes and 180 h private study
Credits:	9
Entrance requirements:	Programmierung 1
Aims / Competences to be developed:	Die Studierenden lernen die Syntax und Semantik der Programmiersprache C++ und die Grundprinzipien der objektorientierten Programmierung kennen. Sie erwerben die Fähigkeit Funktionen, Algorithmen und Klassen in der Programmiersprache C++ zu entwerfen und zu implementieren. Sie lernen die asymptotische Notation kennen und sie trainieren, wie man die Effizienz von Datenstrukturen und Algorithmen bestimmt und beurteilt. Die Studierenden lernen die wichtigsten effizienten Datenstrukturen und Algorithmen kennen. Eines der Hauptlernziele ist es, den Studierenden die Fähigkeit zu vermitteln, geeignete elementare Datenstrukturen und Algorithmen auf vorgegebene Probleme anzuwenden bzw. neue effiziente Datenstrukturen und Algorithmen für interessante Aufgabenstellungen zu entwickeln. Ferner sollen die Problemlösefähigkeiten der Studierenden durch die

	Vermittelung und Anwendung von Problemlösestrategien trainiert werden.
Content:	**C++ und objektorientierte Programmierung** • Deklarationen und Definitionen von Variablen • Einfache Datentypen • Ausdrücke • Kontrollstrukturen und Schleifenanweisungen • Unterprogramme, Module, Parameterübergabe • Polymorphismus: Überladen von Funktionen • Gültigkeitsbereiche und Sichtbarkeit von Variablen • Eingabe in und Ausgabe von Dateien • Zeiger/Pointer • Strukturierte Datentypen • Funktionstemplates • Abstrakte Datentypen und Klassen • Zugriffsrechte: public, private, protected • Konstruktoren, Kopierkonstruktoren, Zuweisungsoperatoren, Destruktoren • Klassentemplates • Vererbung • Polymorphismus: Überladen von Operatoren • C++-Standardbibliothek: Container (vector, list, queue, dequeue, map), Iteratoren, Funktoren **Asymptotische Notation und Laufzeitanalyse** • Was sind Algorithmen? • Laufzeit als eine Funktion der Größe der Eingabe • RAM, primitive Operationen, Abschätzung von Rechenzeiten • Asymptotische Notation **Wahrscheinlichkeitstheorie und erwartete Laufzeiten** • Ereignisse und Ereignisräume, Stichproben/Kombinatorik • Wahrscheinlichkeitsräume und –verteilungen • Bedingte Wahrscheinlichkeiten, Satz von Bayes • Zufallsvariablen • Erwartungswerte, Linearität des Erwartungswerts • Unabhängige Zufallsvariablen • Varianz und Standardabweichung • Markow- und Chebychev-Ungleichung, Chernoff-Schranke **Elementare Datenstrukturen** • Felder, Listen, Queues, Stacks • Binäre Suchbäume, Rot-Schwarz-Bäume, AVL-Bäume • Binäre Min-Heaps **Rekursion und Rekurrenzen**

	• Substitutionsmethode • Rekursionsbäume • Master-Theorem **Hashing** • Kollisionen und Chaining • Uniformes Hashing • Universelles Hashing • Offene Adressierung • Perfektes Hashing **Sortieren** • Insertion-Sort • Merge-Sort, Divide-and-Conquer • Quick-Sort • Heap-Sort • Bucket-Sort • Untere Schranke für das vergleichsbasierte Sortieren **Graphen und Graph-Algorithmen** • Gerichtete und ungerichtete, vollständige und bipartite Graphen • Pfade, Rundgänge und Kreise • Zusammenhangskomponenten • BFS und DFS • Topologisches Sortieren • Starke Zusammenhangskomponenten • Shortest Path: Bellmann-Ford und Dijkstra • Minimum Spanning Tree: Kruskal / Prim, Greedy-Strategie • Euler-Rundgang und Euler-Graphen
Assessment / Exams:	Erfolgreiche Bearbeitung der praktischen und theoretischen Übungsblätter: Um zur Klausur (und der Nachklausur) zugelassen zu werden, müssen die Studierenden mindestens 50 % der Programmierübungen und mindestens 50 % der theoretischen Übungen erfolgreich bearbeiten. Bestehen der Abschlussklausur oder der Nachklausur Benotung: ja Die Note entspricht der Note der Abschlussklausur (bzw. der besten Note von Abschlussklausur und Nachklausur). Die Nachklausur findet innerhalb der letzten beiden Wochen vor Vorlesungsbeginn des Folgesemesters statt.
Used Media:	Vorlesung: Powerpoint-Folien + Skript (LaTeX) + Tafel Übungen:

	Programmierübungen am Computer, theoretische Übungen in Gruppen an der Tafel
Literature:	**Algorithmen und Datenstrukturen** • T.H.Cormen, C.E.Leiserson, R.L.Rivest and C. Stein. *Introduction to Algorithms - Second Edition*. McGraw-Hill, 2001. (ISBN: 0262531968) • K.Mehlhorn and S.Näher. *The LEDA Platform of Combinatorial and Geometric Computing*. Cambridge University Press, 1999. (ISBN 0521563291) • K.Mehlhorn, P.Sanders. Informatik V: Data Structures and Algorithms. Skript zur Vorlesung im SS 2000 **C++** • Breymann. C++ Einführung und professionelle Programmierung • C++-Referenz • StanleyB.Lippman, Josee Lajoie. *C++ Primer*. Addison Wesley 1998. (ISBN: 0201824701) • Bjarne Stroustrup. *The C++ Programming Language*. Addison Wesley Publishing Company 1997. (ISBN: 0201889544)

Program of Studies:	Master Program Visual Computing
Name of the module:	Softwarepraktikum
Abbreviation:	CS 320 / SoDePra
Subtitle	
Modules:	Lecture 2 h (daily) Practice 6 h (daily)
Semester:	1st-3rd Semester / offered each September
Responsible lecturer:	Prof. Dr. Andreas Zeller
Lecturer(s):	Prof. Dr. Andreas Zeller, Prof. Dr. Philipp Slusallek, Prof. Dr. Holger Hermanns
Language:	German
Level of the unit / mandatory or not:	Elective
Course Type / weekly hours:	Lecture 2 h (daily) Practice 6 h (daily) Teams of up to 6 students
Total workload:	150h vorbereitendes Selbststudium & Programmierung 150 h preparation and programming 6 week block course (30 days): • 12 Lectures of 2h each • Daily: 1h meeting with the tutor • Daily: 4h of work in the team • Daily: 3h self study and programming • overall: 416h
Credits:	14
Entrance requirements:	Programmieren 1 und Programmieren 2
Aims / Competences to be developed:	Die Studierenden erwerben die Fähigkeit, im Team zu arbeiten und Probleme der Informatik zu lösen. Die Studierenden wissen, welche Probleme beim Durchführen eines Software-Projekts auftreten können, und wie man damit umgeht. Sie können eine komplexe Aufgabenstellung eigenständig in ein Software-Produkt umsetzen, das den Anforderungen des Kunden

	entspricht. Hierfür wählen sie einen passenden Entwicklungsprozess, der Risiken frühzeitig erkennt und minimiert, und wenden diesen an. Sie sind vertraut mit Grundzügen des Software-Entwurfs wie schwache Kopplung, hohe Kohäsion, Geheimnisprinzip sowie Entwurfs- und Architekturmustern und sind in der Lage, einen Entwurf anhand dieser Kriterien zu erstellen, zu beurteilen und zu verbessern. Sie beherrschen Techniken der Qualitätssicherung wie Testen und Gegenlesen und wenden diese an. Sie erlernen im praktischen Umgang diverse Facetten des Projektmanagments, der Teamarbeit und Selbstorganisation, sowie Zeitmanagment, Kundenorientierung, und Kommunikationskompetenz.
Content:	Software-Entwurf (objektorientierter Entwurf mit UML) Software-Prozesse (Wasserfall, inkrementelles Modell, agile Modelle) Arbeiten im Team Projektplanung und -Durchführung Qualitätssicherung Programmierwerkzeuge (Versionskontrolle, Konstruktion, Test, Fehlersuche)

Assessment / Exams:	• Individuelles Bearbeiten einer komplexen Entwurfs- und Programmieraufgabe
	• Erfolgreiches Erstellen im Team eines komplexen Software-Produkts, insbesondere
	    o Einreichen der erforderlichen Dokumente
	    o Abnahme des Endprodukts durch den Kunden
	    o Einhaltung der Termin- und Qualitätsstandards
	
	Das Praktikum findet als 6-wöchiges Blockpraktikum in der Sommerpause statt. Dem eigentlichen Praktikum vorangestellt ist eine im Selbststudium zu erarbeitende größere Programmieraufgabe. In dieser erarbeitet sich der Studierende hinreichende praktische Programmierkenntnisse in C/C++. Die erfolgreiche Anfertigung der Programmieraufgabe wird vor Beginn des eigentlichen Praktikums überprüft.
	
	In den ersten zwei Wochen des Blockpraktikums wird dann auf der Basis eines fertig ausgearbeiteten Pflichtenheftes - mit vollständig automatisch testbaren Anforderungen - das System entworfen. Nach einer Woche muss das UML-Objektmodell (Klassen und ihre Beziehungen) stehen. Meilenstein nach einer weiteren Woche ist der vollständige Entwurf, der neben einem überarbeiteten Objektmodell eine Reihe von Standard-

	Szenarien mit Sequenzdiagrammen und Unit-Tests beschreibt. In der Entwurfsphase beurteilt ein Dozent oder ein wissenschaftlicher Mitarbeiter jeden Entwurf in zwei Kolloquien je Gruppe und Tutor. Hierbei geht der Prüfer den Entwurf mit der Gruppe durch, prüft, ob die gesamte Gruppe mit dem Entwurf vertraut ist, und gibt eine Reihe von Auflagen mit auf den Weg, um den Entwurf zu verbessern. Nach abgeschlossenem Entwurf wird ein überarbeitetes Pflichtenheft ausgegeben, in dem sich einige Details geändert haben. Die Studierenden wissen zu Beginn, dass sich Details ändern können (aber nicht, welche Details das sind) und streben angesichts dieses Risikos einen möglichst flexiblen Entwurf an. In den folgenden zwei Wochen wird das System implementiert. Meilenstein ist hier das Bestehen eines vorgegebenen automatischen Tests, der die gesamte Funktionalität des Systems abdeckt. In den letzten zwei Wochen wird das System eingesetzt. Anstelle der Kundenorientierung tritt dabei ein kompetetives Element, da sich jede Implementierung für ein Turnier qualifizieren muss, und anschliessend in dem Turnier möglichst erfolgreich bestehen soll. Hier können insbesondere fortgeschrittene algorithmische Methoden der Informatik ihren Nutzen zeigen.
Used Media:	Gruppenarbeit am Rechner Präsentation mit Tafel und Folie Demonstration für den Kunden
Literature:	Balzert, Einführung in die Softwaretechnik I + II Gamma et al., Entwurfsmuster

Program of Studies:	Master Program Visual Computing
Name of the module:	Software Engineering
Abbreviation:	CS 560 / SE
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1st -3rd Semester / At least once every two years
Responsible lecturer:	Prof. Dr. Andreas Zeller
Lecturer(s):	Prof. Dr. Andreas Zeller
Language:	English
Level of the unit / mandatory or not:	Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 25 students
Total workload:	270 h = 90 h of classes and 180 h private study
Credits:	9
Entrance requirements:	
Aims / Competences to be developed:	The students know and apply modern software development techniques They are aware of advanced quality assurance techniques such as test coverage, program analysis, and verification and know about the appropriate standards. They know modern paradigms of programming and design, and know when to use them. They know the standards of project management and project organization and can assess the state of given projects as well as suggest consequences to reach specific targets.
Content:	• Software Processes (Testing process, ISO 9000, maturity model, extreme programming) • Modeling and design (requirements engineering, formal specification, proofs, model checking)

	• Programming paradigms (aspect-oriented, generative, and component-based programming) • Validation (Testing, Reliability assessment, tools) • Software maintenance (configuration management, reengineering, restructuring) • Project skills (organization, structure, estimations) • Human resources (communication, assessment) • Controlling (metrics, change requests, risk and quality managament)
Assessment / Exams:	• Regular attendance of classes and tutorials • Passing the final exam • A re-exam takes place during the last two weeks before the start of lectures in the following semester.
Used Media:	Slides, beamer, presentations with laptop, labs using computer
Literature:	Balzert, Softwaretechnik I and II Own lecture notes

Program of Studies:	Master Program Visual Computing
Name of the module:	Algorithms and Data Structures
Abbreviation:	CS 574 / A&D
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1st -3rd Semester / At least once every two years
Responsible lecturer:	Prof. Dr. Kurt Mehlhorn
Lecturer(s):	Prof. Dr. Kurt Mehlhorn, Prof. Dr. Raimund Seidel, Dr. Ernst Althaus, Dr. Ulrich Meyer
Language:	English
Level of the unit / mandatory or not:	Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 25 students
Total workload:	270 h = 90 h of classes and 180 h private study
Credits:	9
Entrance requirements:	For graduate students: C, C++, Java
Aims / Competences to be developed:	The students know standard algorithms for typical problems in the areas graphs, computational geometry, strings and optimization. Furthermore they master a number of methods and data-structures to develop efficient algorithms and analyze their running times.
Content:	• graph algorithms (shortest path, minimum spanning trees, maximal flows, matchings, etc.) • computational geometry (convex hull, Delaunay triangulation, Voronoi diagram, intersection of line segments, etc.) • strings (pattern matching, suffix trees, etc.) • generic methods of optimization (tabu search, simulated annealing, genetic algorithms, linear programming, branch-and-bound, dynamic programming, approximation algorithms, etc.) • data-structures (Fibonacci heaps, radix heaps, hashing,

	randomized search trees, segment trees, etc.) • methods for analyzing algorithms (amortized analysis, average-case analysis, potential methods, etc.)
Assessment / Exams:	• Regular attendance of classes and tutorials • Passing the midterm and the final exam • A re-exam takes place during the last two weeks before the start of lectures in the following semester.
Used Media:	Slides, beamer
Literature:	• Cormen, Leiserson, Rivest and Stein, Introduction to Algorithms, Mc Graw Hill, 2001 • Aho, Hopcroft, Ullman, The Design and Analysis of Computer Algorithms, Addison-Wesley, 1974. • Mehlhorn, Näher, LEDA, A platform for combinatorial and geometric computing, Cambridge Univ. Press, 1999. • Tarjan, Data Structures and Network Algorithms, SIAM, 1983. • Mehlhorn, Data Structures and Algorithms, Vol 1-3, Springer Verlag, 1984. • Knuth, The Art of Computer Programming, Addison Wesley.

Program of Studies:	Master Program Visual Computing
Name of the module:	Optimization
Abbreviation:	CS 579 / OPT
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1^{st} -3^{rd} Semester / At least once every two years
Responsible lecturer:	Dean Computer Science
Lecturer(s):	Dr. Fritz Eisenbrand
Language:	English
Level of the unit / mandatory or not:	Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 25 students
Total workload:	270 h = 90 h of classes and 180 h private study
Credits:	9
Entrance requirements:	
Aims / Competences to be developed:	The students learn to model and solve optimization problems from theory as from the real world
Content:	• Linear Programming: Theory of polyhedra, simplex algorithm, duality, ellipsoid method • Integer linear programming: Branch-and-Bound, cutting planes, TDI-Systems • Network flow: Minimum cost network flow, minimum mean cycle cancellation algorithm, network simplex method • Matchings in graphs: Polynomial matching algorithms in general graphs, integrality of the matching polytope, cutting planes • Approximation algorithms: LP-Rounding, greedy methods, knapsack, bin packing, steiner trees and forests, survivable network design
Assessment / Exams:	• Regular attendance of classes and tutorials

	• Solving accompanying exercises, successful partcipation in midterm and final exam • Grades: Yes • The grade is calculated from the above parameters according to the following scheme: 20%, 30%, 50% • A re-exam takes place during the last two weeks before the start of lectures in the following semester.
Used Media:	Practical exercises supplement the theoretical exercises. The lecture is accompanied with a difficult real-world optimization problem which is solved by the students in teams within the scope of an optimization contest.
Literature:	Bernhard Korte, Jens Vygen: Combinatorial Optimization, Theory and Algorithms, Springer Verlag, 2001 Alexander Schrijver: Theory of Linear and Integer Programming, Wiley-Interscience, 1986 Alexander Schrijver: Combinatorial Optimization, Springer Verlag, 2002

Mechatronics

Program of Studies:	Master Program Visual Computing
Name of the module:	Grundlagen der Signalverarbeitung
Abbreviation:	
Subtitle	
Modules:	Lecture 2 h (weekly) Tutorial 2 h (weekly)
Semester:	1st-3rd Semester
Responsible lecturer:	Prof. Dr. Dietrich Klakow
Lecturer(s):	Prof. Dr. Dietrich Klakow
Language:	German
Level of the unit / mandatory or not:	Elective
Course Type / weekly hours:	Lecture 2 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 15 students
Total workload:	180 h = 56 h of classes and 124 h private study
Credits:	6
Entrance requirements:	Knowledge of mathematics (calculus, linear algebra)
Aims / Competences to be developed:	The students will aquire knowledge of the basics methods in signal processing as well as experience in using a small selection of algorithms
Content:	• Einführung (Signale, LTI, ...) • Laplace-Transformation • Fourier-Transformation • FFT • Korrelation von Signalen • Statistische Signalbeschreibung • Z-Transformation

Assessment / Exams:	• Regular attendance of classes and tutorials • Presentation of a solution during a tutorial • Final exam (120 minutes, written)
Used Media:	Powerpoint slides, projector, blackboard
Literature:	Bernd Girod, Rudolf Rabenstein und Alexander Stenger “Einführung in die Systemtheorie”

Program of Studies:	Master Program Visual Computing
Name of the module:	Digital Signal Processing
Abbreviation:	
Subtitle	
Modules:	Lecture 2 h (weekly) Tutorial 2 h (weekly)
Semester:	1st-3rd Semester
Responsible lecturer:	Prof. Dr. Dietrich Klakow
Lecturer(s):	Prof. Dr. Dietrich Klakow
Language:	English
Level of the unit / mandatory or not:	Elective
Course Type / weekly hours:	Lecture 2 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 15 students
Total workload:	180 h = 56 h of classes and 124 h private study
Credits:	6
Entrance requirements:	Sound knowledge of mathematics as tought in computer science, engineering or physics.
Aims / Competences to be developed:	The students will aquire knowledge of the basics methods in digital signal processing as well as experience in how to use them on a computer or dedicated hardware.
Content:	• Digital Signal Processors • Real Time Programming • Signal Representation (e.g. LPC) • Feature Extraction from Speech • Feature Extraction from Images • Feature Transforms (KLT, LDA) • Noise Suppression and Filtering • Speech Coding (PCM, CELP)

Assessment / Exams:	Regular attendance of classes and tutorials Presentation of a solution during a tutorial Final exam (30 minutes, oral)
Used Media:	Powerpoint slides, projector, whiteboard
Literature:	Dietrich W. R. Paulus, Joachim Hornegger "Applied Pattern Recognition" John R. Deller "Discrete-Time Processing of Speech Signals" Sen Kuo "Digital Signal Processors"

Physics

Program of Studies:	Master Program Visual Computation
Name of the module:	Introduction to Physics I for Students of Natural Sciences
Abbreviation:	
Subtitle	
Modules:	Lecture 2 h (weekly) Tutorial 1 h (weekly)
Semester:	1st -3rd Semester / every year in the winter semester
Responsible lecturer:	Prof. Dr. Karin Jacobs (Dean of Studies)
Lecturer(s):	Prof. Dr. Ehses, Prof. Dr. Birringer (variable lecturers)
Language:	German
Level of the unit / mandatory or not:	Elective
Course Type / weekly hours:	Lecture 2 h (weekly) Tutorial 1 h (weekly) Tutorial during lecture class
Total workload:	135 h = 45 h of classes and 90 h private study
Credits:	4,5
Entrance requirements:	
Aims / Competences to be developed:	The aim of this lecture is to give a broad overview of physical methods and concepts on an introductory level to students with only a very basic knowledge of physics. Competences: • encourage students to develop confidence in their own abilities in a science subject. • introduce and develop understanding of some basic physics concepts. • develop students' ability to apply physics concepts to problem solving.
Content:	• Mechanics (e.g. linear and accelerated motion)

	• Energy (forms of energy, work, conservation of energy, kinetic energy, potential energy and efficiency of processes) • Waves (longitudinal and transverse - relation between velocity, frequency, wavelength, reflection and refraction, sound) • Basic Thermodynamics (conduction, convection, radiation, basic thremodynamic processes)
Assessment / Exams:	• Regular attendance of classes and tutorials • Passing a final or re-exam at the end of the semester • Presentation of a solution during a tutorial (at least once) • The re-exam takes place during the last two weeks before the start of lectures in the following semester.
Used Media:	Demonstration experiments, slides, beamer, blackboard, movies
Literature:	• D. Halliday, R. Resnick, J. Walker: Physik, Wiley-VCH, 2001 • Trautwein, Kreibig, Oberhausen, Hüttermann: Physik für Mediziner, Biologen, Pharmazeuten, 5. Auflage (1999), Walter de Gruyter, Berlin, New York 2000 • K. Lüders: Physik für Naturwissenschaftler, Verlag Dr. Köster, Berlin.

Program of Studies:	Master Program Visual Computation
Name of the module:	Introduction to Physics II for Students of Natural Sciences
Abbreviation:	
Subtitle	
Modules:	Lecture 2 h (weekly) Tutorial 1 h (weekly)
Semester:	1st -3rd Semester / every year in the summer semester
Responsible lecturer:	Prof. Dr. Karin Jacobs (Dean of Studies)
Lecturer(s):	Prof. Dr. Ehses, Prof. Dr. Birringer (variable lecturers)
Language:	German
Level of the unit / mandatory or not:	Elective
Course Type / weekly hours:	Lecture 2 h (weekly) Tutorial 1 h (weekly) Tutorial during lecture class
Total workload:	135 h = 45 h of classes and 90 h private study
Credits:	4,5
Entrance requirements:	
Aims / Competences to be developed:	The aim of this lecture is to give a broad overview of physical methods and concepts on an introductory level to students with only a very basic knowledge of physics. Competences: • encourage students to develop confidence in their own abilities in a science subject. • introduce and develop understanding of some basic physics concepts. • develop students' ability to apply physics concepts to problem solving.
Content:	• Electricity and Circuits (charge, current, potential, resistance, Ohm's Law, energy and power in d.c.) • Electromagnetic Spectrum • Basic knowledge in optics (lenses, diffraction and refraction)
Assessment / Exams:	• Regular attendance of classes and tutorials

	• Passing a final or re-exam at the end of the semester • Presentation of a solution during a tutorial (at least once) • The re-exam takes place during the last two weeks before the start of lectures in the following semester.
Used Media:	Demonstration experiments, slides, beamer, blackboard, movies
Literature:	• D. Halliday, R. Resnick, J. Walker: Physik, Wiley-VCH, 2001 • Trautwein, Kreibig, Oberhausen, Hüttermann: Physik für Mediziner, Biologen, Pharmazeuten, 5. Auflage (1999), Walter de Gruyter, Berlin, New York 2000 • K. Lüders: Physik für Naturwissenschaftler, Verlag Dr. Köster, Berlin.

Program of Studies:	Master Program Visual Computing
Name of the module:	Physics for Engineers 1
Abbreviation:	--
Subtitle	--
Modules:	Lecture 2 h (weekly) Tutorial 1 h (weekly)
Semester:	1st-3rd Semester
Responsible lecturer:	Prof. Dr. Jacobs (Studiendekanin)
Lecturer(s):	Dr. L. Santen, Priv. Doz. F. Anders
Language:	German
Level of the unit / obligatory or not:	Elective
Course Type / weekly hours:	Lecture 2 h (weekly) Tutorial 1 h (weekly) Tutorials in groups of up to 25 students
Total workload:	135 h = 45 h of classes and 90 h private study
Credits:	4,5
Entrance requirements:	
Aims / Competences to be developed:	The aim of this lecture is to give a broad overview of physical methods and concepts on an introductory level.
Content:	The first part of the lecture introduces basic terms (e.g. forces, energy or momentum) and concepts (e.g. Newton's laws or use of conservation laws). This is done by the example of simple systems following the laws of classical mechanics. The introductory part is followed by the discussion of periodic motions and waves, which includes theoretical aspects as well as the corresponding phenomenology (e.g. the propagation of electromagnetic waves).
Assessment / Exams:	• Regular attendance of classes and tutorials • Passing 2 written exams (midterm, final, re-examinations are possible) • Presentation of a solution during a tutorial (at least once) • Passing the practical exercises (teams of up to two students)

Used Media:	Beamer, experiments, slides
Literature:	• I.S. Grant, W.R. Phillips: The elements of physics, Oxford Univ. Press, 2001 • D. Halliday, R. Resnick, J. Walker: Physik, Wiley-VCH, 2001 • D.C. Giancoli, Physics for Scientists and Engineers, Prentice Hall, 2000

Program of Studies:	Master Program Visual Computing
Name of the module:	Physics for Engineers 2
Abbreviation:	--
Subtitle	--
Modules:	Lecture 2 h (weekly) Tutorial 1 h (weekly)
Semester:	1st-3rd Semester
Responsible lecturer:	Prof. Dr. Jacobs (Studiendekanin)
Lecturer(s):	Dr. L. Santen, Priv. Doz. F. Anders
Language:	German
Level of the unit / obligatory or not:	Elective
Course Type / weekly hours:	Lecture 2 h (weekly) Tutorial 1 h (weekly) Tutorials in groups of up to 25 students
Total workload:	135 h = 45 h of classes and 90 h private study
Credits:	4,5
Entrance requirements:	
Aims / Competences to be developed:	The aim of this lecture is to give a broad overview of physical methods and concepts on an introductory level.
Content:	In the second part of the lecture the discussion of waves is continued, now focussing on optical phenomena. The last part of the lecture addresses several aspects of quantum theory, which are illustrated by discussing the physics of several simple quantum systems.
Assessment / Exams:	• Regular attendance of classes and tutorials • Passing 2 written exams (midterm, final, re-examinations are possible) • Presentation of a solution during a tutorial (at least once) • Passing the practical exercises (teams of up to two students)
Used Media:	Beamer, experiments, slides
Literature:	• I.S. Grant, W.R. Phillips: The elements of physics, Oxford

	Univ. Press, 2001 • D. Halliday, R. Resnick, J. Walker: Physik, Wiley-VCH, 2001 • D.C. Giancoli, Physics for Scientists and Engineers, Prentice Hall, 2000

Master Thesis

Program of Studies:	Master Program Visual Computing
Name of the module:	Master Thesis
Abbreviation:	VC 899
Subtitle	
Modules:	Thesis
Semester:	4th Semester / topics are offered each semester
Responsible lecturer:	Professors of the Department / Program
Lecturer(s):	See above
Language:	English or German
Level of the unit / mandatory or not:	Graduate / Compulsory
Course Type / weekly hours:	n. a.
Total workload:	900 h = 50 h contact hours, 850 h private studies
Credits:	30
Entrance requirements:	
Aims / Competences to be developed:	In the master thesis the student demonstrates his abilitiy to perform independent scientific work focusing on an adequately challenging topic.
Content:	On the basis of the "state-of-the-art", visual computing methods are applied to strive for novel scientific findings, and this application is documented systematically.
Assessment / Exams:	Written elaboration in form of a scientific paper. It describes the scientific findings as well as the way leading to these findings. It contains justifications for decisions regarding chosen methods for the thesis and discarded alternatives. The student’s own substantial contribution to the achieved results has to be evident. In addition, the student presents his work in a colloquium, in which the scientific quality and the scientific independence of his achievements are evaluated.
Used Media:	
Literature:	According to the topic

Tutor

Program of Studies:	Master Program Visual Computing
Name of the module:	Tutor
Abbreviation:	
Subtitle	
Modules:	
Semester:	1st – 3rd Semester / possible every semester
Responsible:	Dean of Studies
Lecturer(s):	Qualified Students
Language:	Deutsch / English
Level of the unit / mandatory or not:	Elective Compulsory for students being in the honors program
Course Type / weekly hours:	Tutorial 2 h (weekly) Tutoring groups of up to 25 students
Total workload:	A tutor assists a course (usually basic or core lectures) for one semester. This includes the following tasks: 0) Learning the specific didactic aspects of the course matter (4h). 1) Moderating the weekly meetings (90 min each) of a tutorial group 2) Correction of weekly tests, taken in the group 3) Weekly office hours (90 min) for students attending the course. 4) Attending weekly team-meetings with all tutors and lecturers of the course (45 min) 5) Participation in developing sample exercise solutions of the weekly assignments (90 min weekly) 6) Answering incoming questions on the mailing list regarding topics of the course and the weekly assignments (60 min weekly) 7) Getting to grips with the contents of the current lecture (2h weekly) 8) Creating new exercises (1h weekly)

	9) Supervising and correcting exams (midterm, final exam, re-exam, 12h each)
Credits:	4
Entrance requirements:	Each lecturer selects the tutors for his/her courses. A prerequisite for becoming a tutor is a very good grade in the relevant course, interest in didactics and an observable talent for didactical work.
Aims / Competences to be developed:	Tutors learn how courses are being organized and which methodical aims are being followed. They learn how to communicate complex scientific subject matters to larger groups and in individual meetings. Before starting their work the students attend one or more colloquia in which they are introduced to the specific didactic aspects of the course matter. In assisting the course, they learn how to adapt to the different background knowledge and intellectual capicities of the attending students. They get encouraged to communicate complex contexts in a concise and effective way. In addition they get used to communicating subject matters in English.
Content:	See above
Assessment / Exams:	The lecturer supervises tutors and gives them feedback regarding their contributions to weekly assignments (creating, finding sample solutions for exisiting eercises), answers to questions on the mailing list as well as correcting the exams. The assistant of the course visits each tutorial once a semester and gives feedback to the tutor as well as to the lecturer. At the end of the semester each students evaluates the work of his/her tutor as a part of the course evaluation.
Used Media:	Paper and blackboard
Literature:	

Language Courses: Foreign Languages and German

Program of Studies:	Master Program Visual Computing
Name of the module:	Courses at the Language Center of Saarland University are offered for the following languages: Chinese, Danish, English (Unicert level 3 and higher), French, Greek, Italian, Japanese, Catalan, Korean, Croatian, Dutch, Polish, Portugese, Russian, Swedish and Spanish
Abbreviation:	
Subtitle:	Depends on the level and type of the course
Modules:	Usually 2-4 h Seminar (weekly)
Semester:	1.-4. Semester / courses are offered each semester
Responsible lecturer:	Dr. Peter Tischer, head of the Language Center
Lecturer(s):	http://www.szsb.uni-saarland.de/mitarbeiter/
Language:	German and taught language
Level of the unit / mandatory or not:	For each language taught at the center, different levels are offered: beginner, intermediate and advanced level Elective
Course Type / weekly hours:	Seminar with 2 - 4 hours of classes each week, independent study with monthly meetings or 4 week intensive courses with 4 h of classes each day. Groups of 6 to 40 students
Total workload:	90 h = 30 h classes and 60 h private study 180 h = 80 h classes and 100 h private study
Credits:	3 credits for a 2 h course 6 credits for a 4 h course 6 credits for an intensive course
Entrance requirements:	For the beginners level: none English: at least Unicert level 2 French, Spanish: assessment test to ascertain the proficiency of each student For all other courses on an advanced level: proof of other language courses or meeting with the lecturer. The language center (Sprachenzentrum) ensures that the course level is neither too high nor too low for the student (assessment tests, talks to the lecturer)

Aims / Competences to be developed:	Language skills: grammar, vocabulary, conversation skills.
Content:	Depending on course
Assessment / Exams:	Usually exam at the end of the semester and regular attendance (at least 80 % of all classes).
Used Media:	Textbooks, blackboards, language labs, video
Literature:	Depending on course

Program of Studies:	Master Program Visual Computing
Name of the module:	German Language Course for Beginners
Abbreviation:	
Subtitle	
Modules:	Seminar 6 h (weekly)
Semester:	1st-3rd Semester / courses are offered each semester
Responsible lecturer:	Sabine Chomard
Lecturer(s):	
Language:	German
Level of the unit / mandatory or not:	1.- 4. Semester / international Master students only Elective
Course Type / weekly hours:	Seminar 6 h of classes each week Groups of up to 25 students
Total workload:	270 h = 80 h of classes and 190 h private study
Credits:	9
Entrance requirements:	For the beginners level: none
Aims / Competences to be developed:	Students should develop basic skills in • Reading / understanding German texts • Understanding spoken German • Conducting a German conversation • German Grammar • Writing German texts
Content:	See above
Assessment / Exams:	Weekly assignments One presentation Exam at the end of the semester Regular attendance (at least 75% of all classes)
Used Media:	Textbooks, newspaper, audiotapes, video
Literature:	Depending on the level and topics of the courses

Program of Studies:	Master Program Visual Computing
Name of the module:	German Language Courses / all levels
Abbreviation:	
Subtitle	
Modules:	Seminar 4 h (weekly)
Semester:	1st-3rd Semester / courses are offered each semester
Responsible lecturer:	Sabine Chomard
Lecturer(s):	
Language:	German
Level of the unit / mandatory or not:	1.-4. Semester / international Master students only Elective
Course Type / weekly hours:	Seminar 4 h of classes each week Groups of up to 25 students
Total workload:	180 h = 60 h of classes and 120 h private study
Credits:	6
Entrance requirements:	The Center for German as a Foreign Language (International Office) ensures that the course level is neither too high nor too low for the student (assessment tests, talks to the lecturer)
Aims / Competences to be developed:	Students should develop advanced skills in • Reading / understanding German texts • Understanding spoken German • Conducting a German conversation • German Grammar • Writing German texts
Content:	See above
Assessment / Exams:	Weekly assignments One presentation Exam at the end of the semester Regular attendance (at least 75% of all classes)
Used Media:	Textbooks, newspaper, audiotapes, video
Literature:	Depending on the level and topics of the courses

Program of Studies:	Master Program Visual Computing
Name of the module:	German as a Foreign Language
Abbreviation:	DaF
Subtitle	
Modules:	Lecture 2 h (weekly) Tutorial 2 h (weekly)
Semester:	1.-4. Semester/ Courses are offered each semester
Responsible lecturer:	Kerstin Meyer-Ross
Lecturer(s):	NN
Language:	English / German
Level of the unit / mandatory or not:	Elective
Course Type / weekly hours:	Seminar / 4 SWS / ca. 10 Pers.
Total workload:	4 h + homework + written & oral exam
Credits:	6
Entrance requirements:	The Center for German as a Foreign Language (International Office) ensures that the course level is neither too high nor too low for the student (assessment tests, talks to the lecturer)
Aims / Competences to be developed:	Improving the Language Knowledges
Content:	Practicing the German language by Listening and Speaking
Assessment / Exams:	Final Exam
Used Media:	Printouts, Videos etc.
Literature:	Depending on the level and topics of the courses

Softskills Seminar

Program of Studies:	Master Program Visual Computing
Name of the module:	Softskills Seminar
Abbreviation:	SSS
Subtitle	-- --
Modules:	Lecture 60 h (weekly) Tutorial 60 h (weekly)
Semester:	
Responsible lecturer:	Kerstin Meyer-Ross
Lecturer(s):	Kerstin Meyer-Ross
Language:	English
Level of the unit / mandatory or not:	Graduate / Elective
Course Type / weekly hours:	Blockseminar 120 h 40 h preparation / 40 h course / 40 h private study
Total workload:	120 h
Credits:	4
Entrance requirements:	-- --
Aims / Competences to be developed:	1. Communication In this part, students learn about the meaning of communication in their every day professional and private life. After an introduction to communication theory including body language and verbal, non-verbal and vocal aspects of communication, there will be exercises dealing with body language, voice sound and team communication, as well as advice concerning communication techniques and handling conflicts. 2. Job Hunting Tailor-made for the students' needs, this is a theoretical and practical training for job application. Students learn about self-assessment, orientation, career planning and the actual application process. The layout and content of a CV and cover letter are discussed, as well as the structure of a job interview, rules concerning conduct and appearance, and advice for assessment centres. Students will enter realistic role play sessions with job interviews and an assessment centre. 3. Scientific Posters Scientists quite often have to present their work as a poster. This part covers the planning phase and the actual realisation, explaining rules for content and layout with respect to the target audience, the use of colours and illustrations, text formatting, as well as special requirements of the print medium as opposed to on-screen presentations. The students are shown examples of existing posters.

	Finally, they analyse a poster they brought themselves and correct it. 4. Presentation Skills Topics are: how to structure a presentation, designing PowerPoint slides, visual aids and technical equipment, handling questions, timing, dealing with nervousness, how to give proper feedback. Exercises deal with posture, breathing, voice and body language. Students give individual presentations and are video-taped by staff. They get individual feedback and can watch themselves on film. In a second session of presentations, the students can check on their improvement. 5. Time and Self Management Students learn to identify time wasters and to keep an activity log. They are taught how to set work priorities by classifying their goals and arranging them in 4 categories (Eisenhower principle); they learn about action plans and to-do-lists, as well as effective scheduling. Practical exercises introduce creativity techniques (brainstorming, mindmapping®, decision tree) and mnemo techniques. 6. Project Management The following issues are dealt with: the different planning phases, possible problems, communicating in the right way, defining targets, making vague ideas into specific parts of the plan, the right level of detail, network diagrams and Gantt charts, delegating work, guiding a team, risk management, bringing the project to a close, and post-project evaluation. The course also includes a practical exercise. 7. Scientific Writing This part consists of a detailed lecture, as well as practical exercises and deals with the general structure of a paper and related issues. Students also learn about the process of publishing a paper: rules for submitting a manuscript, dealing with the reviewers' comments etc.
Content:	See above
Assessment / Exams:	2 hand in presentations - your log - application / cv / ad - scientific text
Used Media:	Papers, videos, beamer, blackboard
Literature:	Adair, John Effective communication the most important management tool of all London Pan 1997

Literature:	Adair, John Effective communication the most important management tool of all London Pan 1997 Covey, Stephen R. The seven habits of highly effective people restoring the character ethic reissued London Simon & Schuster 1999 Forsyth, Patrick Ready made activities for PRESENTATION SKILLS Pitman Publishing 1994 Portny, Stanley E. Project management for Dummies 9. print. New York, NY Wiley 2001 Silyn-Roberts, Heather Writing for science and engineering : papers, presentations and reports Oxford Butterworth-Heinemann 2003 Thompson, Mary Anne The global resume and CV guide New York, NY Wiley 2000 Tufte, Edward R. Envisioning information 9. print. Cheshire, Conn. Graphics Press 2003