Module MAT-65-10-M-4

Foundations in Mathematical Image Processing (M, 9.0 LP, AUSL)

Module Identification

Module Number	Module Name	CP (Effort)
MAT-65-10-M-4	*Foundations in Mathematical Image Processing*	9.0 CP (270 h)

Basedata

CP, Effort	9.0 CP = 270 h
Position of the semester	1 Sem. irreg.
Level	[4] Bachelor (Specialization)
Language	[EN] English
Module Manager	Steidl, Gabriele, Prof. Dr. (PROF | DEPT: MAT) (/staff/35/)
Lecturers	Steidl, Gabriele, Prof. Dr. (PROF | DEPT: MAT) (/staff/35/) + further Lecturers of the department Mathematics (/staff/dept/MAT/)
Area of study	[MAT-SPAS] Analysis and Stochastics
Reference course of study	[MAT-88.105-SG] M.Sc. Mathematics (/mhb/FB-MAT/cos-538/)
Livecycle-State	[AUSL] Phase-out period

Notice

The lecture associated to the module was offered in SS 2017 for the last time.

Without a proof of successful participation in the exercise classes, only 6 credit points will be awarded for the module.

Courses

Type/SWS	Course Number	Choice in Module-Part	SL	PL	CP	Sem.
4V+2U	**MAT-65-10-K-4** (/mhb/courses/MAT-65-10-K-4/)	P	U-Schein	PL1	9.0	irreg.

- About **[MAT-65-10-K-4]** (/mhb/courses/MAT-65-10-K-4/): Title: "Foundations in Mathematical Image Processing"; Presence-Time: 84 h; Self-Study: 186 h
- About **[MAT-65-10-K-4]** (/mhb/courses/MAT-65-10-K-4/): The study achievement **"[U-Schein] proof of successful participation in the exercise classes (ungraded)"** must be obtained.

Examination achievement PL1

- Form of examination: **oral examination (20-30 Min.)**
- Examination Frequency: irregular (by arrangement)
- Examination number: 84225 ("Foundations in Mathematical Image Processing")

Evaluation of grades

The grade of the module examination is also the module grade.

Contents

From [MAT-65-10-K-4] Foundations in Mathematical Image Processing (/mhb/courses/MAT-65-10-K-4/):

- Digital image (format, color spaces, sampling, quantization, basic task of image processing),
- Basic Cluster and segmentation algorithms (Mittel, K-means-Algorithms),
- Intensity transformations (Gamma correction, histogram specification),
- Filter (linear filter, bilateral filter, M-regularisator, in particular: median filter),
- Fourier series and discrete Fourier Transform (Series convergence, DFT, FFT),
- Multidimensional Fourier series (DFT, applications in image processing),
- Continuous Fourier Transform,
- Windowed Fourier Transform (Heisenberg's Uncertainty Principle, Gabor Transform).

Competencies / intended learning achievements

Upon completion of this module, the students know the basic questions, concepts and methods of mathematical image processing. By concrete examples, they have gained a clear understanding of the concepts and the application of the methods. They understand the mathematical background required for the methods used (in particular: Intensity transformations, Linear and Nonlinear filters) and they are able to critically assess the possibilities and limitations of the use of these methods.

In addition, the students have learnt the basic problems and concepts of classical Fourier analysis with numerous practical applications. They have mastered the most important methods and will be able to apply them to selected tasks from image processing. They have understood the proofs presented in the lecture and are able to comprehend and explain them.

By completing the given exercises, the students have developed a skilled, precise and independent handling of the terms, propositions and techniques taught in the lecture. In addition, they have learnt how to apply these techniques to new problems, analyze them and develop solution strategies.

Literature

From [MAT-65-10-K-4] Foundations in Mathematical Image Processing (/mhb/courses/MAT-65-10-K-4/):

Literature on mathematical fundamentals:

- K. Bredies, D. Lorenz: Mathematische Bildverarbeitung. Einführung in Grundlagen und moderne Theorie,
- T. Chan, J. Shen: Image processing and analysis. Variational, PDE, Wavelet, and Stochastic Methods,
- O. Scherzer, M. Grasmair, H. Grossauer, M. Haltmeier, F. Lenzen: Variational Methods in Imaging.

Literature on computer science aspects:

- R. C. Gonzalez, R. E. Woods: Digital Image Processing,
- B. Jähne: Digital Image Processing,
- C. Solomon, T. Breckon: Fundamentals of Digital Image Processing. A Practical Approach with Examples in Matlab.

Literature on Fourier Analysis:

- G. Folland: Fourier Analysis and its Applications,
- G. Folland: Real Analysis,
- T. Körner: Fourier Analysis,
- H. Nussbaumer: Fast Fourier Transforms and Convolution Algorithms,
- J. Ramanathan: Methods of Applied Fourier Analysis.

Registration

Registration for the exercise classes via the online administration system URM (https://urm.mathematik.uni-kl.de (https://urm.mathematik.uni-kl.de)).

Requirements for attendance of the module (informal)

Modules:

- [MAT-10-1-M-2] Fundamentals of Mathematics (M, 28.0 LP) (/mhb/modules/MAT-10-1-M-2/)
- [MAT-14-11-M-3] Introduction to Numerical Methods (M, 9.0 LP) (/mhb/modules/MAT-14-11-M-3/)
- [MAT-14-14-M-3] Stochastic Methods (M, 9.0 LP) (/mhb/modules/MAT-14-14-M-3/)

Courses

- [MAT-12-23-K-3] Introduction to Functional Analysis (2V+1U, 4.5 LP) (/mhb/courses/MAT-12-23-K-3/)

Requirements for attendance of the module (formal)

None

References to Module / Module Number [MAT-65-10-M-4]

Course of Study	Section	Choice/Obligation
[MAT-88.105-SG] M.Sc. Mathematics (/mhb/FB-MAT/cos-538/)	[Core Modules (non specialised)] Applied Mathematics	[WP] Compulsory Elective
[MAT-88.706-SG] M.Sc. Mathematics International (/mhb/FB-MAT/cos-553/)	[Core Modules (non specialised)] Applied Mathematics	[WP] Compulsory Elective
[MAT-88.118-SG] M.Sc. Industrial Mathematics (/mhb/FB-MAT/cos-539/)	[Core Modules (non specialised)] General Mathematics	[WP] Compulsory Elective