

## Module Handbook

TUK MODHB Homepage

# Module MAT-65-11-M-7

Methods of Convex Analysis in Image Processing (M, 9.0 LP)

## Module Identification

Module Number	Module Name	CP (Effort)
MAT-65-11-M-7	<i>Methods of Convex Analysis in Image Processing</i>	9.0 CP (270 h)

## Basedata

CP, Effort	9.0 CP = 270 h
Position of the semester	1 Sem. irreg.
Level	[7] Master (Advanced)
Language	[EN] English
Module Manager	Steidl, Gabriele, Prof. Dr. (PROF   DEPT: MAT)
Lecturers	Steidl, Gabriele, Prof. Dr. (PROF   DEPT: MAT) + further Lecturers of the department Mathematics
Area of study	[MAT-SPAS] Analysis and Stochastics
Reference course of study	[MAT-88.105-SG] M.Sc. Mathematics
Lifecycle-State	[NORM] Active

## Courses

Type/SWS	Course Number	Choice in Module-Part	SL	PL	CP	Sem.
4V+2U	MAT-65-11-K-7	P	-	PL1	9.0	irreg.

- About [MAT-65-11-K-7]: Title: "Methods of Convex Analysis in Image Processing"; Presence-Time: 84 h; Self-Study: 186 h

## Examination achievement PL1

- Form of examination: **oral examination (20-30 Min.)**
- Examination Frequency: irregular (by arrangement)
- Examination number: 86306 ("Methods of Convex Analysis in Image Processing")

## Evaluation of grades

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

### Contents

#### From [MAT-65-11-K-7] Methods of Convex Analysis in Image Processing:

- motivation: basic problems of image processing (image restoration: denoising, removal of blur, inpainting; segmentation),
- convex sets (basic concepts, convex cone, projection and separation theorems),
- convex functions (basic concepts, continuity of convex functions, convex optimization problems),
- subgradients (basic concepts, subdifferential calculus, set-valued mappings),
- duality (Legendre-Fenchel conjugate, Lagrange functions, saddle point problems),
- numerical optimization methods with application to image processing problems.

### Competencies / intended learning achievements

Upon successful completion of this module, the students know the basic terms and structures of Convex Analysis. They are familiar with numerical algorithms and can apply them to various problems of digital image processing. They understand the mathematical background required for the algorithms and can critically assess the possibilities and limitations of the use of the algorithms. They understand the proofs presented in the lecture and are able to reproduce and explain them. In particular, they can critically assess, what conditions are necessary for the validity of the statements.

By completing the given exercises, the students have developed a skilled, precise and independent handling of the terms, propositions and methods of the lecture. Moreover, they have gone through different implementations of the algorithms for applications in image processing.

### Literature

#### From [MAT-65-11-K-7] Methods of Convex Analysis in Image Processing:

- A. Auslender, M. Teboulle: Asymptotic Cones and Functions in Optimization and Variational Inequalities,
- H. H. Bauschke, P. L. Combettes: Convex Analysis and Monotone Operator Theory in Hilbert Spaces,
- K. Bredies, D. Lorenz: Mathematische Bildverarbeitung,
- I. Ekeland, R. Temam: Convex Analysis and Variational Problems,
- F. Facchinei, J.-S. Pang: Finite-Dimensional Variational Inequalities and Complementarity Problems, volume I + II,
- J.-B. Hiriart-Urruty, C. Lemarechal: Convex Analysis and Minimization Algorithms, volume 1 + 2,
- J.-B. Hiriart-Urruty, C. Lemarechal: Fundamentals of Convex Analysis,
- R. T. Rockafellar: Convex Analysis,
- R. T. Rockafellar, R. J.-B. Wets: Variational Analysis.

### Requirements for attendance of the module (informal)

#### Modules:

- [MAT-10-1-M-2] Fundamentals of Mathematics (M, 28.0 LP)
- [MAT-14-11-M-3] Introduction to Numerical Methods (M, 9.0 LP)
- [MAT-65-10-M-4] Foundations in Mathematical Image Processing (M, 9.0 LP, AUSL)

### Requirements for attendance of the module (formal)

None

## References to Module / Module Number [MAT-65-11-M-7]

Module-Pool	Name
[MAT-65-MPOOL-7]	Specialisation Image Processing and Data Analysis (M.Sc.)
[MAT-8x-MPOOL-7]	Specialisation Modelling and Scientific Computing (M.Sc.)
[MAT-AM-MPOOL-7]	Applied Mathematics (Advanced Modules M.Sc.)