

Module Description

24-M-AN-HAN Harmonic Analysis

Faculty of Mathematics

Version dated May 1, 2026

This module guide reflects the current state and is subject to change. Up-to-date information and the latest version of this document can be found online via the page

<https://ekvv.uni-bielefeld.de/sinfo/publ/modul/533540610>

The current and valid provisions in the module guide are binding and further specify the subject-related regulations (German "FsB") published in the Official Announcements of Bielefeld University.

24-M-AN-HAN Harmonic Analysis

Faculty

Faculty of Mathematics

Person responsible for module

Prof. Dr. Sebastian Herr

Prof. Dr. Moritz Kaßmann

Regular cycle (beginning)

This module is part of a long-term overall curriculum plan for the Master's programme, which ensures that modules with an amount of at least 20 CP are offered in all five fields each year. The module is offered at irregular intervals as part of this overall curriculum planning.

Credit points

10 Credit points

Competencies

Non-official translation of the module descriptions. Only the German version is legally binding.

Students master advanced content and methods of Harmonic Analysis, in particular they can independently carry out very complex proofs in this area requiring a high level of mathematical expertise.

The students are introduced to fine properties of real-variable functions. They are able to recognise fundamental operators in real analysis such as the maximal functions, the Fourier transform, and integral operators arising as fundamental solutions of PDEs. They are able to prove boundedness of such operators, and to employ methods of Fourier analysis which is important for the in-depth analysis of partial differential equations.

Students will be introduced to current research questions in the area of Harmonic Analysis. They are able to recognise and assess further development opportunities and research goals.

Furthermore, regularly, students recognise further-reaching connections to mathematical issues that have already been worked out. They can transfer and apply the knowledge and methods they have learnt so far to deeper mathematical problem areas. Students also expand their mathematical intuition as a result of more intensive study. In combination with other in-depth modules, they will be able to write their own research papers, e.g. a master's thesis in the field of Harmonic Analysis.

In the tutorials, students develop their ability to discuss mathematical topics and thus further prepare themselves for the requirements of the Master's module, in particular for the scientific discussion within the Master's seminar presentation and the defence of their Master's thesis.

Content of teaching

The following advanced content of teaching from the field of Harmonic Analysis is compulsory:

Interpolation, maximal functions, tempered distributions, Fourier analysis, oscillatory integrals and the method of stationary phase, Calderon-Zygmund theory of singular integrals, Fourier multipliers, Littlewood-Paley theory, introduction to pseudodifferential operators

In addition, the following content of teaching can be covered, for example:

Fourier restriction or Strichartz estimates, Infinitely divisible distributions and Levy-Khintchine formula

This module prepares the content of a master's thesis.

Recommended previous knowledge

Real Analysis, Measure and Integration Theory, Lebesgue spaces, basics knowledge of Elliptic Partial Differential Equations

Necessary requirements

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Explanation regarding the elements of the module

Module structure: 1 SL, 1 bPr¹

Courses

Title	Type	Regular cycle	Workload ⁵	LP ²
Lecture Harmonic Analysis	lecture	This module is part of a long-term overall curriculum plan for the Master's programme, which ensures that modules with an amount of at least 20 CP are offered in all five fields each year. The module is offered at irregular intervals as part of this overall curriculum planning.	60 h (60 + 0)	2 [Pr]

Tutorials Harmonic Analysis	exercise	This module is part of a long-term overall curriculum plan for the Master's programme, which ensures that modules with an amount of at least 20 CP are offered in all five fields each year. The module is offered at irregular intervals as part of this overall curriculum planning.	90 h (30 + 60)	3 [SL]
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Study requirements

Allocated examiner	Workload	LP ²
Teaching staff of the course Tutorials Harmonic Analysis (exercise) <i>Regular completion of the exercises, each with a recognisable solution approach, as well as participation in the exercise groups for the module's lecture. As a rule, participation in the exercise group includes presenting solutions to exercises twice after being asked to do so as well as regular contributions to the scientific discussion in the exercise group, for example in the form of comments and questions on the proposed solutions presented. The organiser may replace some of the exercises with face-to-face exercises.</i>	see above	see above

Examinations

Allocated examiner	Type	Weighting	Workload	LP ²
Teaching staff of the course Lecture Harmonic Analysis (lecture) <i>(electronic) written examination in presence of usually 120 minutes, oral examination in presence or remote of usually 40 minutes, A remote electronic written examination is not permitted.</i>	e-Klausur o. Klausur o. mündliche e-Prüfung o. mündliche Prüfung	1	150h	5

Legend

- 1 The module structure displays the required number of study requirements and examinations.
 - 2 LP is the short form for credit points.
 - 3 The figures in this column are the specialist semesters in which it is recommended to start the module. Depending on the individual study schedule, entirely different courses of study are possible and advisable.
 - 4 Explanations on mandatory option: "Obligation" means: This module is mandatory for the course of the studies; "Optional obligation" means: This module belongs to a number of modules available for selection under certain circumstances. This is more precisely regulated by the "Subject-related regulations" (see navigation).
 - 5 Workload (contact time + self-study)
- SoSe** Summer semester
- WiSe** Winter semester
- SL** study requirement
- Pr** Examination
- bPr** Number of examinations with grades
- uPr** Number of examinations without grades