Area C – DISCRETE MATHEMATICS

Foundation in Discrete Mathematics F4C1:

- **Combinatorics, Graphs, Matroids** (winter term)
- **Linear and Integer Optimization** (summer term)

Lectures of Foundation modules may be taught in German.

Core Lecture Courses (taught in English)**:**

- **V4C1 Combinatorial Optimization** (winter term)
- **V4C2 Approximation Algorithms** (summer term)
- **V4C3 Chip Design** (summer term)

Advanced Lecture Courses (taught in English)**:**

- **V5C1 Advanced Topics in Discrete Mathematics**
- **V5C2 Selected Topics in Discrete Mathematics**

Typical topics treated in advanced lecture courses include for example:

- **Scheduling** (e.g. single/parallel machine models, open shop, flow shop and job shop models, timetabling, transportation, on-line models)
- **Flows over Time** (e.g. maximum flows over time, time-expanded networks, earliest arrival flows, quickest transshipment, minimum-cost flows over time, load-dependent transit times)
- **Facility Location** (e.g. uncapacitated facility location, primal-dual algorithms, scaling and greedy augmentation, capacitated facility location, universal facility location)
- **Steiner Trees** (e.g. euclidean and rectilinear Steiner tree problems, Steiner trees in graphs, exact Steiner tree algorithms, approximation algorithms and inapproximability results)

Useful supplementary courses from other areas:

- **F4E1 Scientific Computing I**
- **V4E1 Numerical Algorithms**
- **F4F1 Stochastic Processes**
- **V4F1 Stochastic Analysis**
- **V4F2 Markov Processes**

You will find the list of modules that are actually offered in a given term in the course overview BASIS at https://basis.uni-bonn.de.
Please note that the summer/winter distribution can sometimes differ from the general schedule shown in the example curricula. Therefore please check BASIS first!

Recommended Curricula

- In all modules in Area C, a basic knowledge of graph theory, graph algorithms, network flows, linear optimization and complexity theory is assumed.
- If you did not take any course on linear programming or graph algorithms during your Bachelor studies, we recommend that you start with one of the Foundation modules “Combinatorics, Graphs, Matroids’’ or “Linear and Integer Optimization’’ or both, and take the core modules “Combinatorial Optimization’’ or “Approximation Algorithms’’ afterwards (Option I).
- If you have already enough knowledge in Area C you may directly start with one of the core modules “Combinatorial Optimization’’ or “Approximation Algorithms’’ (Option II).

Area C – DISCRETE MATHEMATICS

Start in the Winter Term – October:

- **Option I**
    1. Combinatorics, Graphs, Matroids (F4C1)
    2. Chip Design (V4C3) + Approximation Algorithms (V4C2)
    3. Combinatorial Optimization (V4C1)
    4. Selected Topics in Discrete Mathematics (V5C2)
- **Option II**
    1. Combinatorial Optimization (V4C1)
    2. Chip Design (V4C3) + Approximation Algorithms (V4C2)
    3. Advanced Topics in Discrete Mathematics (V5C1)
    4. Selected Topics in Discrete Mathematics (V5C2)

Example Curriculum- Major Area C – Start in the Winter Term (October)

<table>
<tr><th></th><th colspan="4">Major
(Area C)</th><th>Minor
(Area A)</th><th>Minor
(Area F)</th></tr>
<tr><td>1</td><td>Combinato-rial Optimi-zation

9 CP</td><td colspan="3"></td><td>Foundati-ons in Re-presenta-tion Theory

9 CP</td><td>Markov Processes

9 CP</td></tr>
<tr><td>2</td><td>Chip Design

9 CP</td><td>Approxi-mation Algorithms

9 CP</td><td>Grad. Sem. on Discrete Optimiza-tion

6 CP</td><td></td><td>Advanced Topics in Mathema-tical Logic

7 CP</td><td rowspan="3"></td></tr>
<tr><td>3</td><td>Advanced Topics in Discrete Mathematics

7 CP</td><td rowspan="2">Master's Thesis
+
Master's Thesis Seminar

30 CP
+
6 CP</td><td>Grad. Sem. on Applied Combinat. Optimiz.

6 CP</td><td>Practical Training Course
Algorithms for Chip Design

9 CP</td><td rowspan="2"></td></tr>
<tr><td>4</td><td>Selected Topics in Discrete Mathematics

5 CP</td><td colspan="2"></td></tr>
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Area C – DISCRETE MATHEMATICS

Start in the Summer Term – April:

- **Option I**
    1. Chip Design (V4C3) + Linear and Integer Optimization (F4C1)
    2. Combinatorial Optimization (V4C1)
    3. Approximation Algorithms (V4C2)
    4. Advanced Topics in Discrete Mathematics (V5C1)
- **Option II**
    1. Chip Design (V4C3) + Approximation Algorithms (V4C2)
    2. Combinatorial Optimization (V4C1)
    3. Selected Topics in Discrete Mathematics (V5C2)
    4. Advanced Topics in Discrete Mathematics (V5C1)

Example Curriculum- Major Area C – Start in April

<table>
<tr><th></th><th colspan="4">Major
(Area C)</th><th>Minor
(Area E)</th><th>Minor
(Area F)</th></tr>
<tr><td>1</td><td>Chip Design

9 CP</td><td>Approxi-
mation
Algorithms

9 CP</td><td></td><td rowspan="2"></td><td>Numerical
Simulation

9 CP</td><td></td></tr>
<tr><td>2</td><td>Combinato-
rial Optimi-
zation

9 CP</td><td></td><td>Grad. Sem.
on Applied
Combinat.
Optimiz.

6 CP</td><td>Adv.Top. in
Num. Meth.
in Science &
Technology

7 CP</td><td>Founda-
tions in
Stochastic
Analysis

9 CP</td></tr>
<tr><td>3</td><td>Selected
Topics in
Discrete
Mathematics

5 CP</td><td rowspan="2">Master's
Thesis
+
Master's
Thesis
Seminar

30 CP
+
6 CP</td><td>Grad. Sem.
on Discrete
Optimiza-
tion

6 CP</td><td>Practical
Training Course
Algorithms
for Chip
Design

9 CP</td><td colspan="2" rowspan="2"></td></tr>
<tr><td>4</td><td>Advanced
Topics in
Discrete
Mathematics

7 CP</td><td colspan="2"></td></tr>
</table>