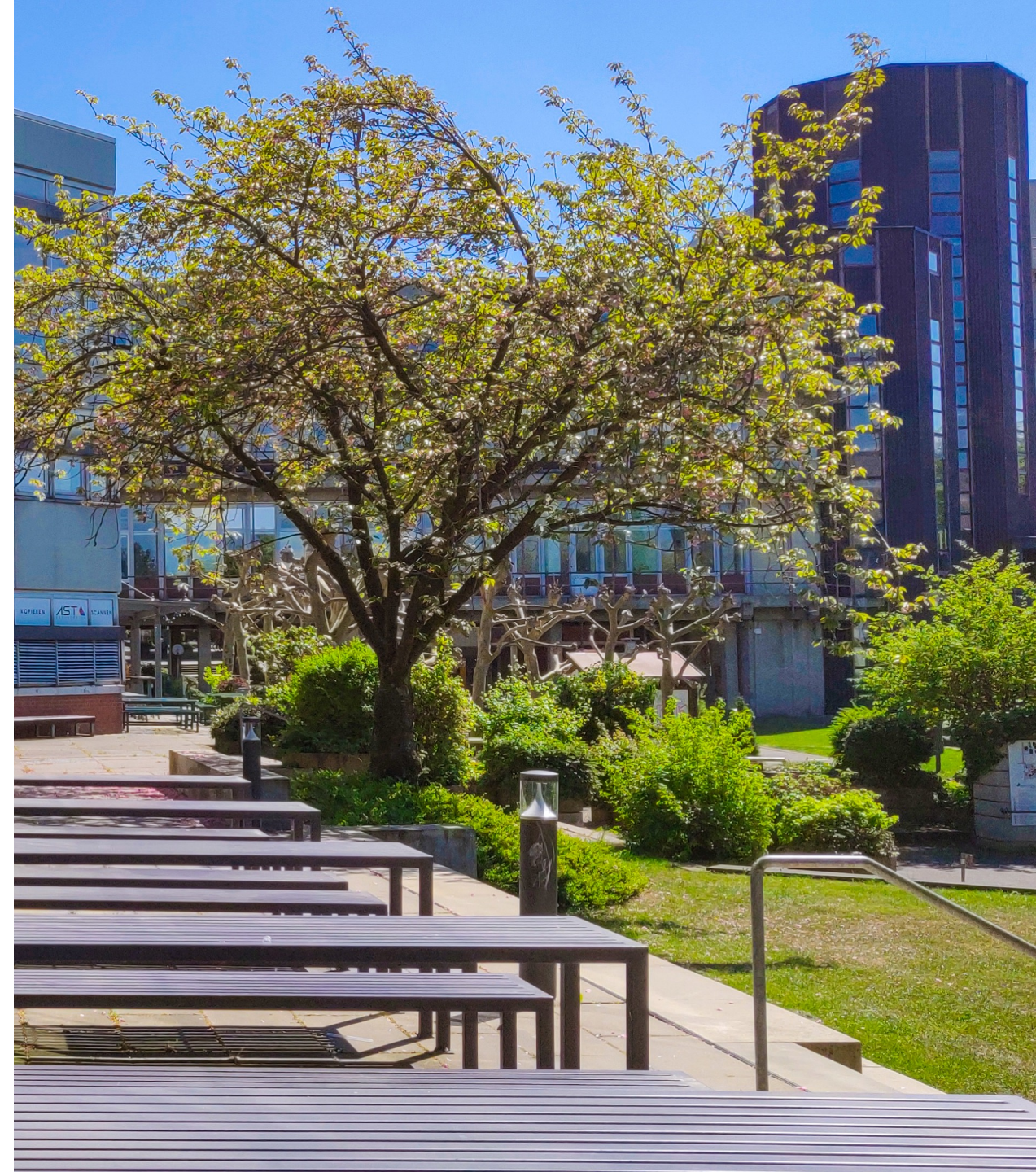# Introduction to the Computer Engineering Master Program

Welcome Days Summer Semester 24

Prof. Dr. Marco Platzner · April 03, 2024

PADERBORN UNIVERSITY

Agenda

1. **Paderborn University (UPB)**

2. **Computer Engineering and Information Technology**

3. **Prerequisites**

4. **Master Computer Engineering**
   a. Program structure
   b. Study elements
   c. Registration and exams

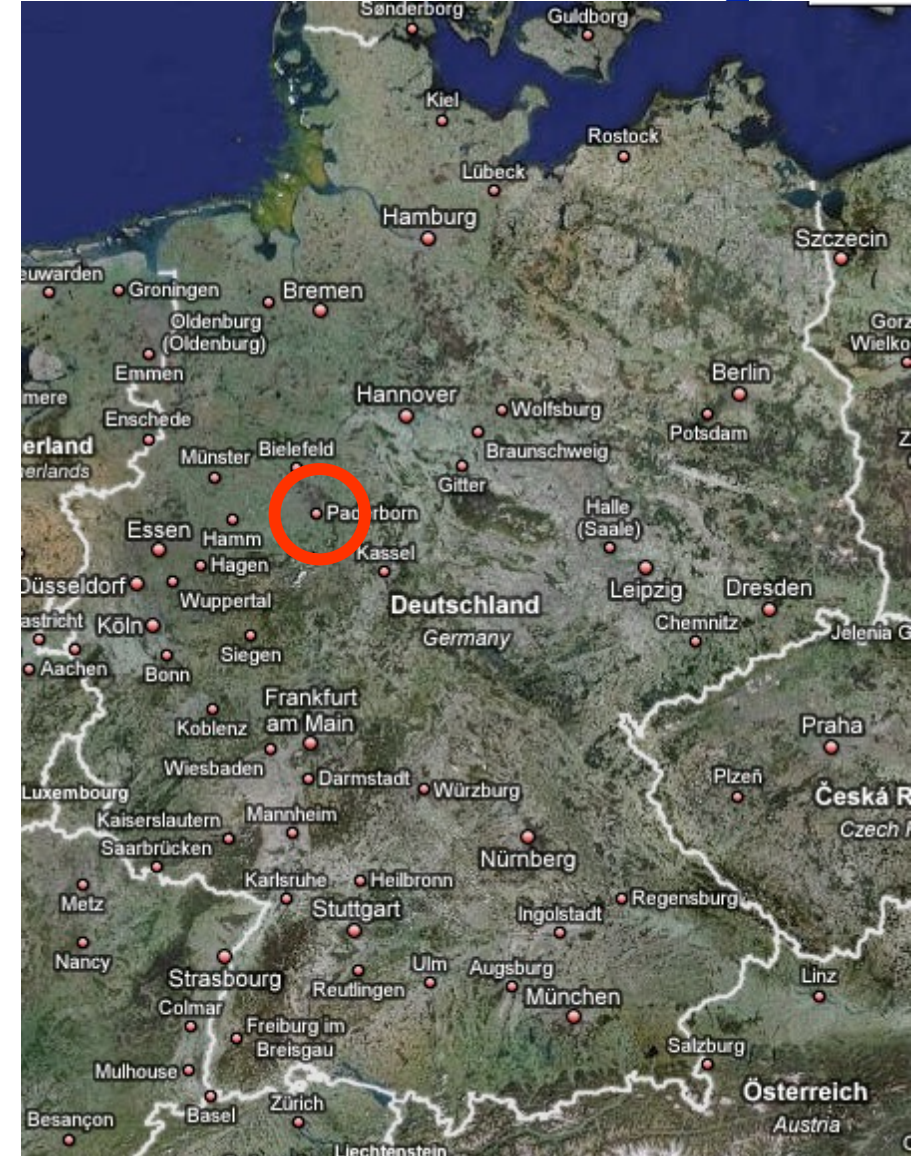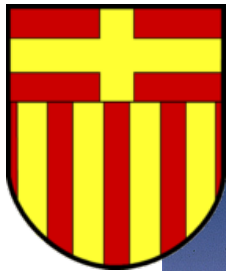5. **Getting Started and Getting Information**

Paderborn University (UPB)

Where is Paderborn?

- Population of 156'000

- First mentioned in 777

- First university founded 1614

- Current university founded 1972

Paderborn University

- Main campus in the southern part of the city
  - Lecture halls, classrooms, workspaces
  - Part of the CS and EE departments
  - Central institutions such as
    - International Office (building I, 4th floor)
    - Central Examination Office (building C, 2nd floor)
    - Notebook Cafe (building I, ground floor)
- Smaller campus at "Fürstenallee"
  - Lecture halls, classrooms, workspaces
  - Part of the CS and EE departments
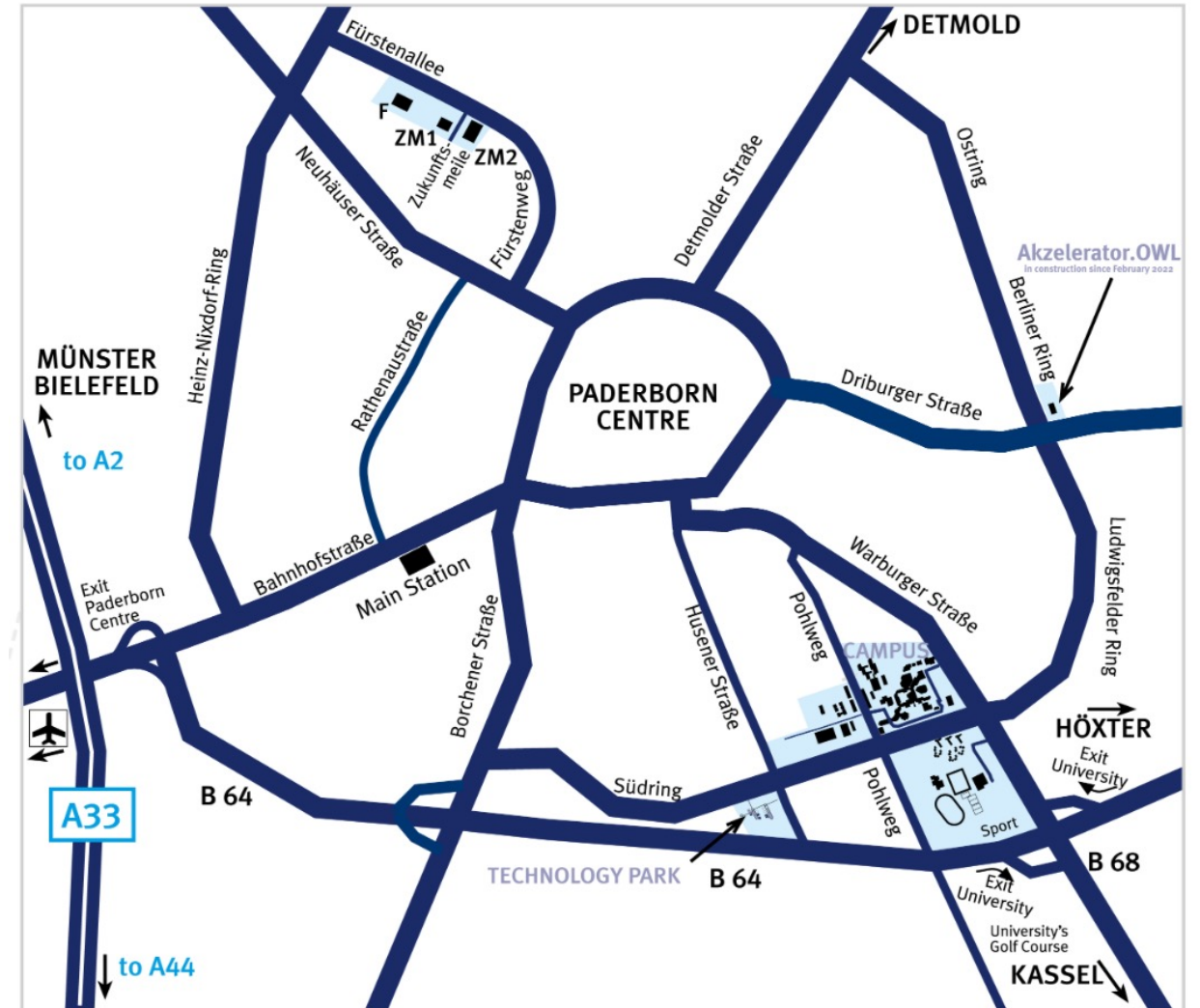
Paderborn University (Statistics as of 2022)

- Students   19,076
- Total staff   2,099 + 707 externally funded
- Academic staff   1,349 + 661 externally funded
- Finances   274,130 T€ + 63,799 T€ external funds

ORIGIN OF STUDENTS (WS 2021/22)

Total	19,076	100 %
Federal state of North Rhine-Westphalia	14,586	77 %
Other German federal states	2,174	11 %
Foreign countries	2,316	12 %

INTERNATIONAL STUDENTS

Continent	Students	Percent
Africa	390	17%
America	46	2%
Asia	1,355	58%
Australia	1	0%
Europe	524	23%
Total	2,316	100%

Paderborn University

- Key research areas
  - Digital humanities
  - Intelligent technical systems
  - Sustainable materials, processes and products
  - Optoelectronics and photonics
  - Transformation and education

- Faculties
  - Faculty for Arts and Humanities
  - Faculty for Business Administration and Economy
  - Faculty for Science
  - Faculty for Mechanical Engineering
  - Faculty for **Computer Science, Electrical Engineering and Mathematics**

Faculty of Computer Science, Electrical Engineering and Mathematics

- Departments
  - Computer Science
  - Electrical Engineering and Information Technology
  - Mathematics

- Study programs
  - **Computer Science** (BA, **MA**)
  - **Computer Engineering** (BA, **MA**)
  - Electrical Engineering (BA, MA)
  - **Electrical Systems Engineering** (**MA**)
  - Mathematics (BA, MA)
  - Industrial Mathematics (BA, MA)

  - Teacher Training in EE, CS, Maths (BA, MA)
  - **Optoelectronics and Photonics** (**MA**)
  - Industrial Engineering (EE + economy) (BA, MA)
  - Business Informatics (BA, MA)

  can be studied in English

Computer Engineering and Information Technology

Information Technology

... timely and entertaining infotainment
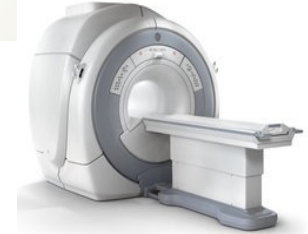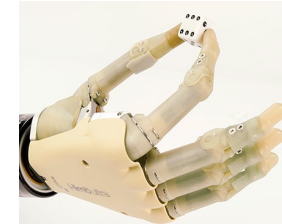
... modern and energy-efficient mobility

... progress in medicine

... networked and secure business

... and many more!

Prof. Dr. Marco Platzner · Introduction to the Computer Engineering Master Program · 03 April 2024

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What is Computer Engineering?

- Construction, analysis and evaluation of computers and computer-controlled systems
  - Such systems consist of **hardware AND software**
  - Knowledge and skills from **Electrical Engineering AND Computer Science** required
  - Key discipline of information technology with great demand for graduates
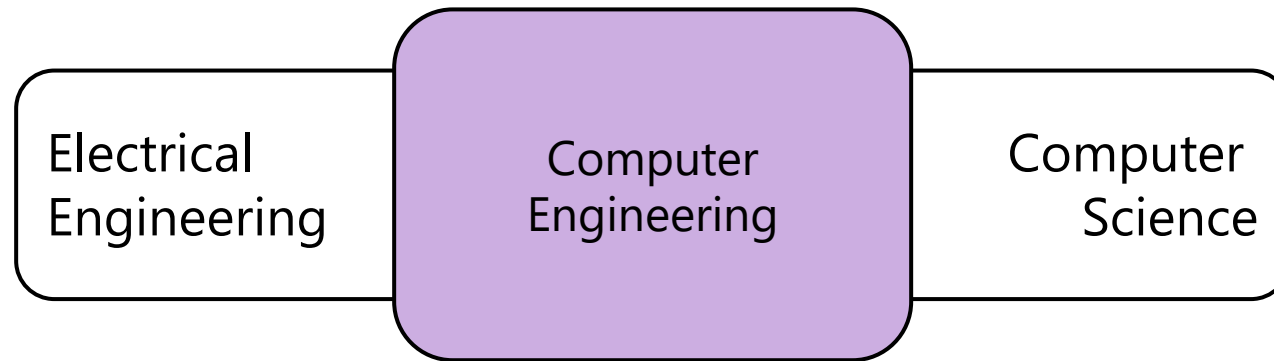
Where Do We Find Computer Engineers?

Research

Development

Production

Management

Training

Technical Monitoring

Marketing and Sales

Measurement and Test Engineering

Consulting and Project Management

Computer Engineering at Paderborn University

- Internationally accepted profile (IEEE/ACM curriculum guidelines)

- Jointly developed and operated by the
  - Department of Computer Science and the
  - Department of Electrical Engineering & Information Technology

Computer Science	Computer Engineering	Electrical Engineering

| Bachelor 🇩🇪 | Bachelor 🇩🇪 | Bachelor 🇩🇪 |
| Master 🇩🇪 🇬🇧 | Master 🇩🇪 🇬🇧 | Master 🇩🇪 🇬🇧 |

Prerequisites

Compatibility of Bachelor Programs

- Bachelor and Master Computer Engineering at UPB are consecutive study programs
- What you have learned in your preceding Bachelor program must roughly match what students have learned in the UPB Bachelor program
- This has been checked before admission but in case you realize deficits in individual courses
    - Ask lecturers about suitable materials for self-study
    - Discuss contents of CE Bachelor courses with local students
    - Work on your own to compensate deficits

What we Expect

- Ability to apply foundations of CS and EE

- Experience with practical work in hardware/software systems

- Initial training in scientific work (seminar, thesis project)
  - searching for and analyzing scientific publications
  - writing scientific documents: adequate structure, clear descriptions and explanations, citations and references, correct use of the English language
  - creating and giving presentations
  - avoiding plagiarism https://cs.uni-paderborn.de/en/studies/formalities/notes-on-plagiarism
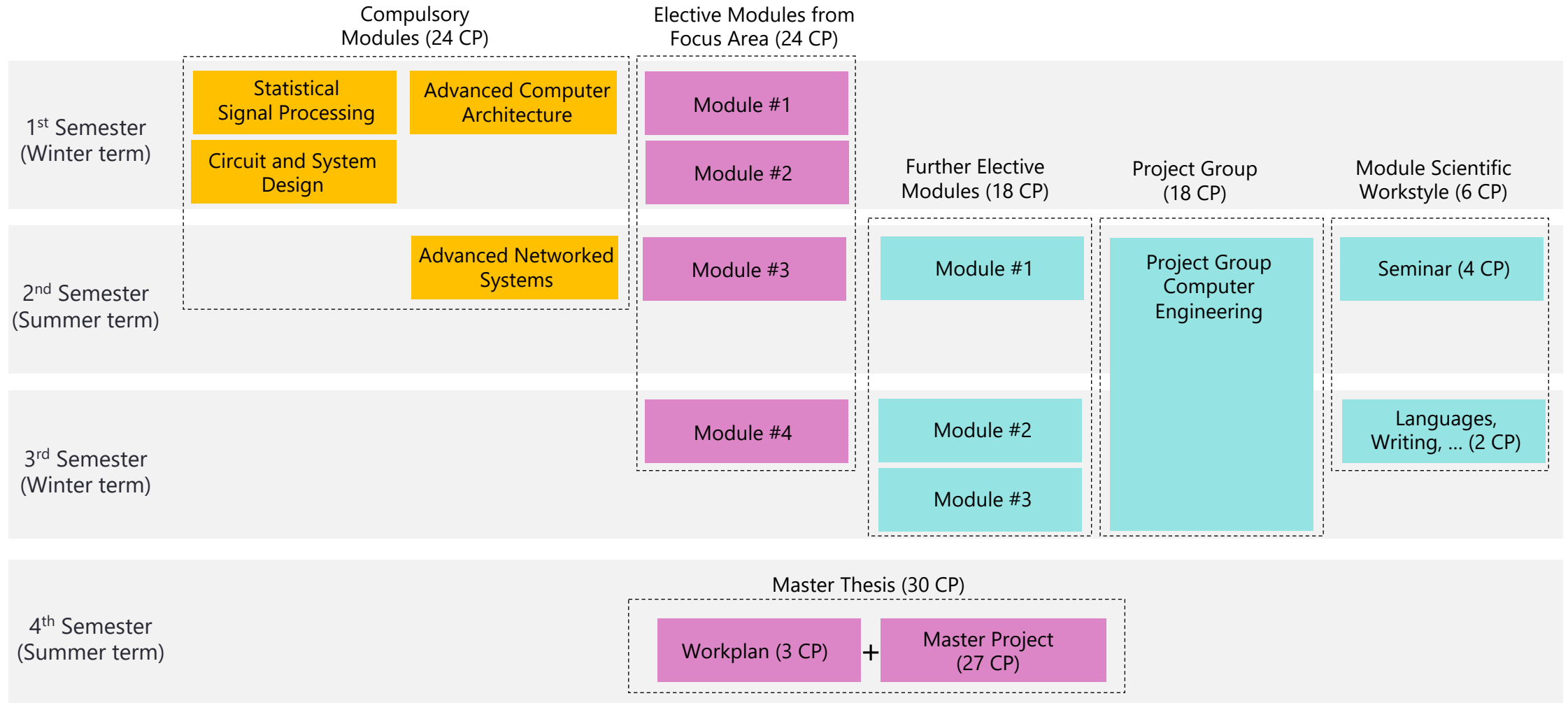
Master Computer Engineering

Master Computer Engineering – Key Facts

- (Nominal) duration of 4 semesters including the Master's thesis

- Degree "Master of Science (M.Sc.)" awarded

- Provides expert knowledge and methods

- Qualifies for advanced jobs in industry and academia (e.g., PhD studies)

Study Plan – Example

	Compulsory Modules (24 CP)		Elective Modules from Focus Area (24 CP)	Further Elective Modules (18 CP)	Project Group (18 CP)	Module Scientific Workstyle (6 CP)
1st Semester (Winter term)	Statistical Signal Processing	Advanced Computer Architecture	Module #1			
	Circuit and System Design		Module #2			
2nd Semester (Summer term)		Advanced Networked Systems	Module #3	Module #1	Project Group Computer Engineering	Seminar (4 CP)
3rd Semester (Winter term)			Module #4	Module #2		Languages, Writing, … (2 CP)
				Module #3		

Master Thesis (30 CP)

4th Semester (Summer term)	Workplan (3 CP) **+** Master Project (27 CP)

Focus Areas of the Computer Engineering (CE) Master

- Embedded Systems

- Nano/Microelectronics

- Computer Systems

- Communication and Networks

- Signal, Image and Speech Processing

- Control and Automation

Modules

- Modules are basic building blocks of the study program
- Modules may combine several courses, but in CE mostly one module = one course
- There are compulsory and elective modules
- Modules have an assigned workload, measured in ECTS credits or credit points (CP)
- Details are described in the Module Handbook (published every semester on the web)

Module Computer Science II
(6 CP)

Advanced Computer Architecture

Module Scientific Workstyle (6 CP)

Seminar (4 CP)

Languages, Writing, ... (2 CP)

CP or ECTS Credits
- 1 CP = 30 hours workload
- 30 CP per semester
- Master program has 120 CP in total

Module Handbook – Example "Advanced Computer Architecture"

- 6 CP module = 180 hours workload
- 15 weeks teaching period in each term
- Workload splits into
  - contact time (lecture, exercise, lab)
  - self-study time (during the teaching period and also outside the teaching period for exam preparation)

Pflichtmodul Informatik II				
Computer Science II				

Module number:	Workload (h):	Credits:	Regular Cycle:	
M.079.01252	180	6	winter term	
	Semester number:	Duration (in sem.):	Teaching Language:	
	beliebig	1	en	

1 Module structure:

	Course	form of teaching	contact-time (h)	self-study (h)	status (C/CE)	group size (TN)
a)	L.079.05724 Advanced Computer Architecture	L3 Ex2	75	105	CE	50/25

2 Options within the module:
none

3 Admission requirements:
Prerequisites of course Advanced Computer Architecture:
Recommended Proficiencies
Basic knowledge in computer architecture.

5 h contact time / week (3 h lecture + 2 h exercise) x 15 weeks = 75 h contact time
75 h contact time + 105 h self-study = 180 h = 6 CP

4	**Contents:**

Contents of the course Advanced Computer Architecture:
The course teaches concepts and methods used in modern processor architecture to exploit the available parallelism at the levels of instructions, data and threads.

- Fundamentals of computer architectures (refresher)
- Memory hierarchy design
- Instruction-level parallelism
- Data-level parallelism: Vector, SIMD and GPU architectures
- Thread-level parallelism
- Warehouse-scale computer

5	**Learning outcomes and competences:**

After attending the course, the students

- are able to explain principles of modern memory hierarchies,
- to analyze different levels of parallelism,
- to assess the suitability of different architectural concepts and thus
- to evaluate modern developments in computer architecture.

Non-cognitive Skills

- Team work
- Learning competence

6	**Assessments:**

☒Final module exam (MAP)   ☐Module exam (MP)   ☐Partial module exams (MTP)

zu	Type of examination	Duration or scope	Weighting for the module grade
a)	Written or oral examination	90-120 minutes or 40 minutes	100%

The responsible lecturer announces type and duration of assessment modalities in the first three weeks of the lecture period at latest.

7	**Study Achievement:**

zu	Type of achievement	Duration or Scope	SL / QT
a)	Written exercises		CA

Within the first three weeks of the lecture period each respective lecturer will specify the manner in which the course achievement will be conducted.

8	**Prerequisites for participation in examinations:**

Passing of course achievement

9	**Prerequisites for assigning credits:**

The credit points are awarded after the module examination was passed.

10	**Weighing for overall grade:**

The module is weighted as 6 credits.

11	**Reuse in degree courses or degree course versions :**

Masterstudiengang Computer Engineering v3 (CEMA v3)

12	**Module coordinator:**

Prof. Dr. Marco Platzner

13	**Other Notes:**

Remarks of course Advanced Computer Architecture:
Implementation method

- Lecture with projector and board
- Interactive exercises in the lecture room item Computer-based exercises with simulation tools
- Analysis of case studies

Learning Material, Literature

- Lecture slides and exercise sheets
- Exercise sheets and technical documentation for the for the computer-based exercises
- Hennessey, Patterson: Computer Architecture: A Quantitative Approach (5th edition or newer), Morgan Kauf- mann, 2012.
- Information about alternative and additional literature as well as teaching material on the course's website and in the lecture slides

Course (6 CP)

- Comprise typically lecture + exercise and/or lab
  - Exercises can be paper & pencil exercises or programming assignments
  - Sometimes lab work
  - May require to pass a course achievement (e.g., a programming assignment, short report, ...) to be able to register for the exam

- Special case: Course "Languages, Writing and Presentation Techniques" (2 CP)
  - You can choose any course offer from Paderborn University in above topics
  - Use it to individually strengthen your professional skills

Seminar (4 CP)

- Seminars train scientific work style
  - Be aware and learn about good practices and, importantly, avoid the problem of plagiarism (!)

- What is done in a seminar?
  - Lecturers propose a set of topics
  - Students select or are assigned a topic
  - Perform literature search
  - Read, analyze and compare selected literature
  - Prepare and give a presentation with slides
  - Submit a written report

- Seminars do not belong to specific focus areas

Project Group (18 CP)

- What is done in a project group?
  - A team of typically 6-10 students works on a larger project over two semesters
  - Concept and implementation of a hardware/software system
  - Project management (including documentation) is part of the task
  - Work there is highly self-organized, requires your active contribution
  - Usually requires to be present at least two days per week in Paderborn

- Project groups do not belong to specific focus areas

- A technicality
  - Project groups offered in the CS department run over two semesters (18 CP)
  - Project groups offered in the EE department may consist of two consecutive smaller project groups with 9 CP each

Master Thesis (30 CP)

- The Master thesis has 30 CP = one semester full-time (!)
  - Duration of 6 months is formally checked

- Master's thesis (advisor) must be from chosen focus area

- Tasks typically included
  - Study of literature on the assigned topic, familiarize with tools
  - Write work plan (proposal), including a time plan
  - Give an initial presentation that covers the topic and the work plan
  - Conceptual work and/or formal work and/or hardware and software development
  - Experiments and evaluation
  - Write a report with ~80-120 pages on a scientific level
  - Give a final presentation that covers the thesis work (defend your decisions and solutions/results)

Registration

- For a course
  - Register in PAUL for the course, the course achievement, and for the exam (!)
  - Periods for the registrations are displayed in PAUL
  - De-register if you don't want to take an exam. Otherwise, you might get stuck with that course/module.

- For a seminar and for a project group
  - Different seminars and project groups are offered each semester
  - Assignment process in place that starts at the end of the teaching period for offers in the following semester
  - All upcoming project groups are presented in a public event in the last week of the teaching period

- Finding a topic for a Master thesis
  - Address professors/lecturers/research associates working in the areas of your interest
  - Often, Master theses result from project groups
  - Check out research groups' web pages and boards
  - Defining a topic is often an interactive process between student and potential advisor
  - Often, you can also bring own ideas for discussion

Exams

- Exams for courses can be in oral or in written form
  - The form has to be announced in class within the first three weeks of the teaching period
- Written exams are usually offered twice a year
  - Either two exams in the semester break following the teaching period, or one exam in each of the two following semester breaks
- Oral exams require individual appointments with the lecturer
- Exams can be repeated twice (three attempts)
- Passed exams cannot be repeated (!)

| Grading scheme	
1.0, 1.3	very good
1.7, 2.0, 2.3	good
2.7, 3.0, 3.3	satisfactory
3.7, 4.0	sufficient
5.0	failed

More on Exams

- Seminars can also be repeated twice
  - Evaluation of the presentation, seminar report, active participation in discussions
- Project groups can also be repeated twice – but you do not want to do that …
  - Quality of result and reports / presentations as team contributions, individual contribution
- The Master's thesis can only be repeated once, but you really do not want to do that …
  - Evaluation by the advisor and a co-advisor

Even More on Exams

- For elective modules, compensation is possible: The "Container"

- Shifting ("compensating") failed exams
  - A failed exam (failed in 1st, 2nd or 3rd attempt) can be moved into the container and another module can be completed instead

- Improving the overall grade
  - If you pass an exam but have an unsatisfactory result, you can move the module into the container and complete a different module instead

- All passed modules in the container are listed in the Transcript of Records as "extra achievements"

- BUT the container size is limited to 24 CP (!)

failed exams
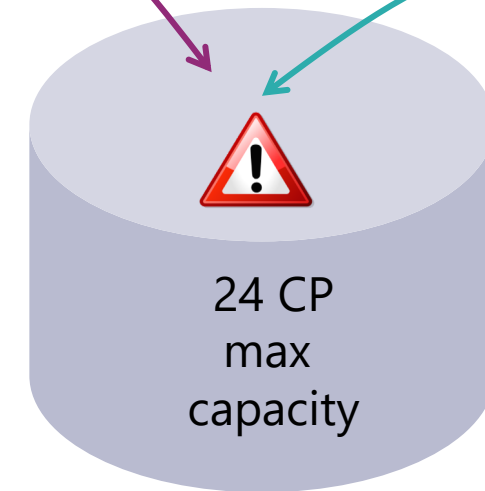
passed exams, but unhappy

24 CP max capacity

Final Failure in the Master Program is Possible, If ...

- You can't pass a compulsory course (or the seminar, or the project group) in 3 attempts

- You can't pass the Master thesis in 2 attempts

- You have no more options to compensate elective courses

- Be careful and serious about exams, do not waste examination attempts (!)

Getting Started and Getting Information

Plan Your First Semester!

- Check the course catalogue at https://paul.uni-paderborn.de

- Navigate to `Overview > Faculty of Computer Science, Electrical Engineering and Mathematics > Computer Science > Computer Engineering Studies (since WiSe17/18) > Master Studies Computer Engineering`

- Browse through the courses in the compulsory area and areas of specialisation to identify courses you might wish to take in this summer term

- If you don't have an idea yet which focus area to select, don't worry! Just pick modules according to your interests.

- Register for the module as well as the course in it. Also, register for the course achievement (if available) and the exam in the corresponding registration periods – and mind the deadlines (!)

- You can't take a seminar or a project group in your first semester

Tips

- You are responsible for planning and organizing your study program
  - Selecting courses, visiting lectures, all the registrations, finding seminars / project group / Master thesis

- Form learning groups
  - Query each other, explain subjects to each other; learn for understanding, not just for repetition of materials
  - Team up with other international students, they are faced with the same situation
  - Team up with local students, they likely have done their Bachelor studies here and know the ropes

- Approach professors and research associates if you have questions
  - That is totally fine and usual here (!)

- Learn some German or at least pick it up on the go
  - This will strongly increase your later job prospects in Germany

- When something is not clear or there is a problem, talk to the lecturer, the study advisors, whoever might be able to help. Don't wait too long!

Common Pitfalls

- Deadlines are indeed important!
    - Some things can be amended if you miss a deadline, others can't and can result in delays of up to one year
    - You are faced with the same situation

- You need to register for all sorts of things!
    - Do it – and mind the deadlines

- If you decide to not go on with course, de-register from it!

    - And from everything associated with the course – and mind the deadlines

Finally: What You Need to Get the Master's Degree

You have to …	ECTS CP
… complete the four compulsory modules	24
… complete four modules in your chosen focus area	24
… complete three modules in whatever area	18
… complete a seminar and a course in Languages, Writing, …	6
… complete a project group	18
… complete a Master's thesis (must be from your focus area)	30
Adding up to	120

It is your own responsibility to meet these criteria!

Getting Information

- CE program website: www.eim.upb.de/ce/en
  - Links to module handbook and examination regulations

- Websites of the departments and their research groups:
  - Department of Computer Science: cs.uni-paderborn.de/en/
  - Department of Electrical Engineering and Information Technology: ei.uni-paderborn.de/en/

- Campus management system: paul.upb.de

- E-Learning platform Panda for individual modules: panda.uni-paderborn.de

- International office: www.uni-paderborn.de/en/studies/international-office

- Central study advice center: zsb.uni-paderborn.de/en/

Contact

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We wish you a successful & enriching study experience at Paderborn University!

> "The best way to predict **THE FUTURE** is to invent it." — Alan Kay