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German A1/ Parts 3 and 4

**Course title**  German A1/ Parts 3 and 4

**ECTS**  4

**Course type**  Course with exercises

**SWS**  4

**Semester**  Winter and Summer

**Workload in hours**  60 hrs

**Lecturer**  Dr. Virginia Wallner

**Course objectives**
- Can understand and use familiar expressions and very basic phrases aimed at meeting concrete everyday needs
- Can introduce themselves and others and ask other people questions about their person
- Can communicate in a simple way if the other person speaks slowly and clearly and is willing to help

http://www.europaeischer-referenzrahmen.de

**Course contents**
- Grammar
  - Prepositions
  - Possessives
  - Dative verbs
  - The imperative-Simple past ‘war/ hatte’
  - The perfect form
  - Word formation
  - Subjunctive II
- Topics
  - Apartments and houses
  - Parts of the body
  - Describing people and their character
  - Household activities
  - Weather
  - Holidays and celebrations
Recommended literature

Teaching methods
• Partner and group work
• Explanation of topics by the lecturer
• Presentations and discussions
• Feedback from the lecturer
• Listening exercises

Assessment method
Written examination, 90 min.

Language of instruction
German

Prerequisites
Successful completion of Level A1/Parts 1 and 2 (88121)

Course descriptions for German language courses at higher levels: https://th-deg.de/en/students/language-electives#german
### English in Technical Contexts B2

<table>
<thead>
<tr>
<th><strong>Course title</strong></th>
<th>English in Technical Contexts B2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ECTS</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Course type</strong></td>
<td>Language training course</td>
</tr>
<tr>
<td><strong>SWS</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Semester</strong></td>
<td>Winter and summer</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Course level</strong></th>
<th><strong>B2</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Can understand the main ideas of complex text on both concrete and abstract topics, including technical discussions in his/her field of specialization</td>
</tr>
<tr>
<td></td>
<td>• Can interact with a degree of fluency and spontaneity that makes regular interaction with native speakers quite possible without strain for either party</td>
</tr>
<tr>
<td></td>
<td>• Can produce clear, detailed text on a wide range of subjects and explain a viewpoint on a topical issue giving the advantages and disadvantages of various options</td>
</tr>
</tbody>
</table>

[http://www.europaeischer-referenzrahmen.de/](http://www.europaeischer-referenzrahmen.de/)

<table>
<thead>
<tr>
<th><strong>Lecturer</strong></th>
<th>Neal O’Donoghue, MA</th>
</tr>
</thead>
</table>

**Course objectives**: This course aims to deepen students’ encounter with the English language in a technical context by giving practical training in specialized vocabulary, grammar and language usage. The four cardinal language skills – listening, speaking, reading, and writing – will play an integral role in this training. The course is designed to be relevant and interesting for engineering students and will be adapted to their learning needs and study areas. By the end of the course, participants should have a more comprehensive understanding of, and enhanced fluency in, the English language in an engineering context.
Course contents

**Obligatory topics (60 %):**
- Numbers and mathematical operations
- Shapes and dimensions
- August 2017
- Basic physics and the scientific worldview
- Materials and their properties
- Case study on an area related to technology
- /physics/engineering
- Grammar/ communication skills

**Variable content (40 %):**
Variable content will be determined on the basis of a student survey conducted in the first session. Current world events (including news events and popular culture) and recent technological innovations may be used as a basis for discussions.

Teaching methods

Teaching methods focus on improving the four cardinal language skills and include group discussions and group projects; individual work; mini-presentations; role-plays; close reading and listening activities; dictation; grammar games; and various follow-up viewing and writing activities. Work not completed in class should be done at home. Self-study assignments will be set on a weekly basis.

Assessment method

Written exam (60 min)

No dictionaries are allowed.

Exam structure:
- Part 1: Listening comprehension(s)
- Part 2: Reading comprehension(s)
- Part 3: Vocabulary and technical content
- Part 4: Grammar (maximum 10% of total exam points, excluding writing exercise)
- Part 5: Writing composition (150-200 words)

The exam will be based on topics covered during the semester.

Recommended Literature


<table>
<thead>
<tr>
<th>Language of instruction</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisites</td>
<td>B1 / Abitur (A-levels/ school leaving certificate giving right of entry to higher education) / 7-9 years of English</td>
</tr>
</tbody>
</table>


# Intercultural Training for Germany and Bavaria

<table>
<thead>
<tr>
<th><strong>Course title</strong></th>
<th>Intercultural Training for Germany and Bavaria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ECTS</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Course type</strong></td>
<td>Elective</td>
</tr>
<tr>
<td><strong>SWS</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Semester</strong></td>
<td>Winter and summer</td>
</tr>
<tr>
<td><strong>Workload in hours</strong></td>
<td>30 hours</td>
</tr>
<tr>
<td><strong>Name of Instructor</strong></td>
<td>Lisa Werner</td>
</tr>
</tbody>
</table>

**Course objectives**

Participants get an understanding of the different theories of “culture” and learn about stereotypes and traditions in Bavaria. Furthermore, the participants get information on Germany and Bavaria as well as the Deggendorf Institute of Technology.

**Course contents**

- **I.** Culture (theories)
- **II.** Customs and Rituals in Germany/Bavaria
- **III.** Information on Germany and Bavaria and the DIT
- **IV.** Quiz and Presentation
- **V.** Culture Shock

**Recommended literature**

- Bolten J. und Ehrhardt C., Interkulturelle Kommunikation, Verlag Wissenschaft & Praxis 2003;
- Bolten J, Einführung in die interkulturelle Wirtschaftskom- munikation, Vandenhoeck & Ruprecht 2007

**Teaching methods**

The course is organized according to four pillars:
1. Culture
2. Customs and Rituals
3. Information on Germany/Bavaria
4. Culture Shock
Whereas hard facts are taught in a classical lecture style, students will do lots of role-plays, critical incidents, short movies and do a quiz.

<table>
<thead>
<tr>
<th>Assessment method</th>
<th>Paper</th>
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</thead>
<tbody>
<tr>
<td>Language of instruction</td>
<td>English/German</td>
</tr>
<tr>
<td>Prerequisites</td>
<td>None</td>
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</table>
### Course title
Asian Emerging Economies and Doing Business in the Asian Region

<table>
<thead>
<tr>
<th>Course ID</th>
<th>299</th>
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<tbody>
<tr>
<td>ECTS</td>
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<tr>
<td>Course type</td>
<td>Elective</td>
</tr>
<tr>
<td>SWS</td>
<td>2</td>
</tr>
<tr>
<td>Semester</td>
<td>Winter and summer</td>
</tr>
<tr>
<td>Lecturer</td>
<td>Ms. Dr. (rer.pol.) Wei Manske-Wang</td>
</tr>
</tbody>
</table>

#### Course objectives
- Establishment of global horizons
- Learning knowledge holistically about Asia: political, economic and social; Past, current development up to the future prognosis
- Awareness of foreign cultures and understanding their causes
- Preparing for the challenges of future professional life in a global environment

#### Course contents
- Institutions and strategic arrangements in Asia: ASEAN, APEC, BRICS, BRI etc.
- PEST country analysis: Japan, China, India etc.
- Profound background: culture and philosophy etc.
- Hot topics in Asia: industrialization, digitization, megacities, mobility, M&A in Europe etc.

#### Recommended literature
<table>
<thead>
<tr>
<th><strong>Teaching methods</strong></th>
<th>Lecture, Press Monitoring, Case Studies, Group Work, Dialogue</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assessment method</strong></td>
<td>Written exam (60 minutes)</td>
</tr>
<tr>
<td><strong>Language of instruction</strong></td>
<td>English</td>
</tr>
<tr>
<td><strong>Prerequisite</strong></td>
<td>Thinking outside the box and willingness to learn</td>
</tr>
</tbody>
</table>
## Basics of International Sales and Business Development

<table>
<thead>
<tr>
<th><strong>Course title</strong></th>
<th>Basics of International Sales and Business Development</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course ID</strong></td>
<td>268</td>
</tr>
<tr>
<td><strong>ECTS</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Course type</strong></td>
<td>Lecture with group work and presentations</td>
</tr>
<tr>
<td><strong>SWS</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Semester</strong></td>
<td>Winter and summer</td>
</tr>
<tr>
<td><strong>Lecturer</strong></td>
<td>Ibrahim Waked</td>
</tr>
<tr>
<td><strong>Course objectives</strong></td>
<td>General knowledge of international sales and strategic business development mechanisms. As well as profound analysis of practical case studies.</td>
</tr>
</tbody>
</table>
| **Course contents** | - Basics of sales and business development  
                        - Analysis of market potential including cultural & political aspects, correlation between microeconomic and demographic aspects, (PESTELO analysis)  
                        - Relevancy of world bank reports on general economic performance and their implementation in company BD strategy  
                        - Market entry and risk management |
| **Recommended literature** | **Strategic Management** by Richard Lynch von Pearson Longman  
                                  **Business Development Management** By Lutz Becker, Walter Gora, Tino Michalski |
| **Teaching methods** | Lecture with integrated project development examples |
| **Assessment method** | Presentation and seminar paper |
| **Language of instruction** | English |

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**Note:** The course name is abbreviated as “Basics of International Sales and Business Development” for simplicity in this representation.
Bavarian Culture

<table>
<thead>
<tr>
<th>Course title</th>
<th>Bavarian Culture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course ID</td>
<td>229</td>
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<tr>
<td>SWS</td>
<td>2</td>
</tr>
<tr>
<td>Semester</td>
<td>Winter and summer</td>
</tr>
<tr>
<td>ECTS</td>
<td>2</td>
</tr>
<tr>
<td>Course type</td>
<td>Elective</td>
</tr>
<tr>
<td>Language of instruction</td>
<td>English</td>
</tr>
<tr>
<td>Name of lecturer</td>
<td>Jennifer Hauer</td>
</tr>
<tr>
<td>Course objectives</td>
<td>Participants get a deeper understanding of the traditional and contemporary Bavarian culture by integrating knowledge about customs, language, and history with culturally routed events.</td>
</tr>
<tr>
<td></td>
<td>1. Hard facts</td>
</tr>
<tr>
<td></td>
<td>1.1. History</td>
</tr>
<tr>
<td></td>
<td>1.2. Demographics</td>
</tr>
<tr>
<td></td>
<td>1.3. Geography</td>
</tr>
<tr>
<td></td>
<td>2. Customs and rituals</td>
</tr>
<tr>
<td></td>
<td>2.1. Traditional</td>
</tr>
<tr>
<td></td>
<td>2.2. Contemporary</td>
</tr>
<tr>
<td></td>
<td>3. Language</td>
</tr>
<tr>
<td></td>
<td>4. Events</td>
</tr>
<tr>
<td>Course contents</td>
<td>The course is organized according to four pillars:</td>
</tr>
<tr>
<td></td>
<td>1. Hard Facts</td>
</tr>
<tr>
<td></td>
<td>2. Customs and Rituals</td>
</tr>
<tr>
<td></td>
<td>3. Language</td>
</tr>
<tr>
<td></td>
<td>4. Events</td>
</tr>
<tr>
<td>Teaching methods</td>
<td>Whereas hard facts are taught in a classical lecture style, students should experience aspects of the culture in a lively manner through knowledge dissemination of cultural experts, off-campus seminars at events of traditional cultural</td>
</tr>
</tbody>
</table>
origin, as well as learning and engaging in cultural rituals themselves. The aim is to deepen and complement the contents taught in the Orientation Week.

<table>
<thead>
<tr>
<th>Recommended literature</th>
<th>Jonas, B., Gebrauchsanweisung für Bayern, Piper Verlag, 2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment methods</td>
<td>Seminar paper</td>
</tr>
<tr>
<td>Prerequisites</td>
<td>Participants should have attended the introductory Intercultural Training during the Orientation Week.</td>
</tr>
</tbody>
</table>
# Business Storytelling

<table>
<thead>
<tr>
<th>Course title</th>
<th>Business Storytelling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course ID</td>
<td>296</td>
</tr>
<tr>
<td>ECTS</td>
<td>2</td>
</tr>
<tr>
<td>Course type</td>
<td>Elective</td>
</tr>
<tr>
<td>SWS</td>
<td>2</td>
</tr>
<tr>
<td>Semester</td>
<td>Winter and summer</td>
</tr>
<tr>
<td>Workload in hours</td>
<td>Total: 60 / In-class: 30 / Self-study: 30</td>
</tr>
<tr>
<td>Lecturers</td>
<td>Diego and Raphael Fiche</td>
</tr>
</tbody>
</table>

At the end of this course, students will be able to:

- Recognize key elements that go into persuasive storytelling
- Identify types of stories and their purposes
- Create compelling stories to achieve business goals
- Apply acquired knowledge to develop a compelling story to persuade others to think or act in a different way.

<table>
<thead>
<tr>
<th>Course contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Business Storytelling</td>
</tr>
<tr>
<td>Power of Business Stories: when and why to tell them</td>
</tr>
<tr>
<td>Types of Business Stories and Their Purposes</td>
</tr>
<tr>
<td>Structuring Your Story to Engage the Audience</td>
</tr>
<tr>
<td>Storytelling techniques</td>
</tr>
<tr>
<td>Enhance Your Storytelling Skills</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Recommended literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Janis Forman (2013), Storytelling in Business: The Authentic and Fluent Organization</td>
</tr>
<tr>
<td>Seth Godin(2005), All Marketers Are Liars</td>
</tr>
</tbody>
</table>
| **Teaching methods** | Lectures  
|                     | Group work  
|                     | Case studies  
|                     | Presentation  
|                     | Exercises  |
| **Assessment method** | Class workshops / presentation / case studies / seminar paper  |
| **Language of instruction** | English  |
| **Prerequisites** | None  |
# Cross-Cultural Team Building

<table>
<thead>
<tr>
<th><strong>Course title</strong></th>
<th>Cross-Cultural Team Building Workshop</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lecturer</strong></td>
<td>Prof. Dr. Johann Nagengast</td>
</tr>
<tr>
<td><strong>Course type</strong></td>
<td>Elective</td>
</tr>
<tr>
<td><strong>SWS</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Semester</strong></td>
<td>Winter and summer</td>
</tr>
<tr>
<td><strong>ECTS</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Assessment method</strong></td>
<td>Seminar paper</td>
</tr>
<tr>
<td><strong>Course language</strong></td>
<td>English</td>
</tr>
</tbody>
</table>

**Course objectives**

Globalisation demands that managers possess the basic skills required to work together in international teams. Many companies actively encourage the development of these skills through teambuilding or team development programs. Especially for change management, team development plays an increasingly important role. Here the critical goal is to optimise how the group members work together as a team. Key factors affecting a team’s success include organisation, structures, processes, culture and relationships.

International Team Building is conducted at the beginning of the semester as a three day off-campus seminar. The hands-on, outdoor training gives the students intensive exposure to the multifaceted nature of group dynamics.

By working together to solve complex problems and through structured feedback sessions, the participants become sensitised to the rolls they assume in group interactions, to the limitations imposed by the German and their own cultures, and to the conditions required for effective team work.
The course supports the integration of foreign students into campus and social life and helps build lasting working relationships among all participants.

The skills of giving and receiving of feedback are learned in the protective atmosphere of small groups through intensive exchanges between instructors and participants. This leads to improved observation and communication skills.

Moreover, the group members continually switch roles. This promotes a deeper understanding of social interaction, helps members to reflect on their contribution to the group process, encourages members to experiment with new behavioural concepts, and improves the group’s capacity to co-operate and perform. Final feedback rounds offer the possibility to align the members’ self-images with the perception others have of them, to reduce “blind spots”, to increase self-confidence and their ability to reflect.

The capacity to give appropriate feedback in various situations, to monitor one’s self-image as well as the consequences of one’s own behaviour form the basis for a successful career in management.

Course contents

Group dynamics, processes and structures in groups; Roles in groups (roles in tasks and supporting roles); Group leadership; Effect of one’s actions in groups; The “give and take” of feedback; Self-image and how others see you; Communication levels (content versus relationship); Conditions for successful co-operation; Cultural influences on teamwork.

Note: The main emphasis of this course is not the conveyance of theoretical knowledge, but rather learning directly from experience. The theories on which the intervention and evaluation sessions are based are taught in the course “Human Resources Management”.

Teaching methods

This course is organised as an interactive experience and activity-based training program. With the help of complex tasks, timed interaction activities combined with elements of surprise, classical outdoor training exercises, moderated feedback and reflection sessions, participants are taught the necessary conditions for effective teamwork.

The teaching methods are based on the principles of self-organised learning. The instructors define their roles in terms of Schein’s model of process consulting.
They intervene by questioning the participants in a manner designed not only to examine their perspectives, but to introduce new perspectives and stimulate the group’s creative process.

The responsibility for these processes remains with the participants.

In the context of the learning environment, the students enjoy the opportunity to increase their observation, communication, co-operation, self-reflection, teamwork and management skills as well as their self-confidence.

In addition, the course offers the students the chance to network and develop sustainable work relationships at the start of their studies.

**Suggested Literature**

Baron, R. S.: Group Process, Group Decision, Group Action, 2nd Ed., Buckingham, 2003;


**Notes**

The weekend seminar is characterised by team teaching in a mountain hostel. The team consists of Prof. Dr. Nagengast and trained tutors selected from participants in the course „Train the Trainer“. The tutors make it possible to conduct the training in small „protected“ groups (around 8) and to give qualified feedback.
## AI Project

### Course title
AI Project

### ECTS
5

### Course type
Project

### SWS
2

### Course level
Undergraduate

### Semester
Summer

### Workload in hours
150 hours

### Lecturer
Prof. Dr. Patrick Glauner

### Course objectives
The aim of this class is to provide students with hands-on and real-world AI development experience. They will have the opportunity to work on real data sets in order to solve real-world problems. As these projects are completed in groups, students will also have the opportunity to use professional software development tools for collaboration.

- Implementing high-tech projects in the fields of artificial intelligence, machine learning, computer vision, natural language processing and others.
- Projects can be chosen for example from Kaggle, from other sources or be done in collaboration with an industrial partner.
- Using modern high-end hardware, such as GPU clusters and cloud services.
- Utilizing an agile process framework such as Scrum.
- Understanding and using modern industrial software development tools such as work package trackers, code revision systems, debuggers, profilers and others.
- Presenting R&D outcomes to stakeholders at different levels, such as fellow students, faculty members, practitioners and executives.

### Course contents
**Recommended literature**


**Teaching methods**

Project

**Assessment method**

Project

**Language of instruction**

English

**Prerequisite**

Foundations of AI and machine learning
# Algorithms and Data Structures

<table>
<thead>
<tr>
<th><strong>Course title</strong></th>
<th>Algorithms and Data Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ECTS</strong></td>
<td>5</td>
</tr>
<tr>
<td><strong>Course type</strong></td>
<td>Lecture and lab</td>
</tr>
<tr>
<td><strong>SWS</strong></td>
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<tr>
<td><strong>Course level</strong></td>
<td>Undergraduate</td>
</tr>
<tr>
<td><strong>Semester</strong></td>
<td>Summer</td>
</tr>
<tr>
<td><strong>Workload in hours</strong></td>
<td>150 hours</td>
</tr>
<tr>
<td><strong>Lecturer</strong></td>
<td>Prof. Dr. Patrick Glauner</td>
</tr>
</tbody>
</table>

**Course objectives**

The aim of this class is to provide an introduction to one of the most important foundations of a computer science degree: algorithms and data structures. A data structure enables a programmer to structure data into conceptually manageable relationships. An algorithm is a finite sequence of well-defined, computer-implementable instructions to solve a class of problems or to perform a computation. Algorithms often operate on data structures. This course provides a journey through computer science. Students will acquire a solid foundation in how the most important algorithms and data structures work. They will also learn how to design efficient algorithms and data structures.

**Course contents**

- Introduction: algorithm definition, classification of algorithms
- Graphs: graph definitions, applications in computer science, shortest path, lowest cost, A*
- Complexity analysis: time complexity, O, Omega, Theta, o and O tilde notations, space complexity
- Lists: arrays, dynamic arrays/lists, amortization, fundamental operations, stacks, queues, linked lists
- Recursion: search, divide and conquer, recurrence relations, master theorem, backtracking, dynamic programming
## Computer Science

- Sorting: bubble sort, selection sort, insertion sort, merge sort, quicksort, lower bounds
- Trees: binary trees, traversing, advanced types of trees, decision trees
- Maps and hash tables: key-value stores, hashing, collision handling
- Selected algorithms: fast matrix multiplication, random number generation, fast inverse square root, prime numbers, Bloom filter, union-find, median of medians, string matching
- Quantum computing: qubits, quantum logic gates, quantum computers, quantum algorithms

### Recommended literature


### Teaching methods

Lecture and lab

### Assessment method

Written examination 90 min.

### Language of instruction

English

### Prerequisite

Programming foundations
Big Data

Course title | Big Data
ECTS | 2.5
Course type | Lecture and seminar
SWS | 2
Course level | Undergraduate
Semester | Summer
Workload in hours | 75 hours
Lecturer | Prof. Dr. Patrick Glauner

Course objectives
The aim of this class is to provide students with an introduction to the field of big data. Students will acquire a solid foundation in how to design and implement big data systems. They will also learn hands-on how to use industrial big data tools. Furthermore, they will understand the limitations of big data-driven approaches and how they can recognize and solve typical issues in big data, such as data quality and biases. As an outcome, they will be able to work on real-world problems that not only require knowledge in AI, but also an expertise in how to use big data infrastructures, frameworks, libraries and tools.

Course contents
- Introduction: 3 Vs, history of big data, selected big data use cases
- Parallelism: parallelism and concurrency, creating threads, global interpreter lock (GIL)
- Revision of database fundamentals: ER diagrams, relational databases, database management systems, queries, indexes, normalization, transactions
- Big data architectures: distributed systems, MapReduce, CAP theorem, speedup through GPUs and FPGAs
- Big data, small data, all data: data quality, biases in data sets, small sample size problems
### Course Content
- MLOps: project lifecycle, challenges, operations, principal components, pipelines, best practices
- Big data for NLP: embeddings, recent advances in NLP, transformers
- Quantum computing: qubits, quantum logic gates, quantum computers, quantum algorithms
- Selected big data infrastructures, frameworks, libraries and tools

### Recommended Literature

### Teaching Methods
- Lecture and seminar

### Assessment Method
- Seminar presentation

### Language of Instruction
- English

### Prerequisite
- Foundations of AI and machine learning
Computer Vision

**Course title**  
Computer Vision

**ECTS**  
5

**Course type**  
Lecture and lab

**SWS**  
4

**Course level**  
Undergraduate

**Semester**  
Summer

**Workload in hours**  
150 hours

**Lecturer**  
Prof. Dr. Patrick Glauner

**Course objectives**  
The aim of this class is to discuss Computer Vision (CV), which allows computers to process visual inputs. We deal every day dozens of times with CV, such as facial recognition, real-time translating camera input or auto-tagging friends in photos. Modern CV algorithms are strongly based on machine learning methods, in particular deep neural networks. Students will acquire knowledge in CV and be able to elaborate it further in the future, for example in projects or further studies. Overall, CV is a cutting-edge field, with many high-pay opportunities for graduates.

**Course contents**  
- Introduction: applications, computational models for vision, perception and prior knowledge, levels of vision, how humans see
- Pixels and filters: digital cameras, image representations, noise, filters, edge detection
- Regions of images: segmentation, perceptual grouping, Gestalt theory, segmentation approaches, image compression
- Feature detection: RANSAC, Hough transform, Harris corner detector
- Object recognition: challenges, template matching, histograms, machine learning
- Convolutional neural networks: neural networks, loss functions and optimization, backpropagation, convolutions and pooling, hyperparameters, AutoML, efficient training, selected architectures
- Image sequence processing: motion, tracking image sequences, Kalman filter, correspondence problem, optical flow
- Foundations of mobile robotics: robot motion, sensors, probabilistic robotics, particle filters, SLAM
- Outreach: 3D vision, generative adversarial networks, self-supervised learning


| Teaching methods | Lecture and lab |
| Assessment method | Project |
| Language of instruction | English |
| Prerequisite | Programming foundations, multivariate calculus |
Datacenter Network Programming

<table>
<thead>
<tr>
<th>Course title</th>
<th>Datacenter Network Programming</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECTS</td>
<td>5</td>
</tr>
<tr>
<td>Course type</td>
<td>Lecture + Lab + Project</td>
</tr>
<tr>
<td>SWS</td>
<td>4</td>
</tr>
<tr>
<td>Course level</td>
<td>Postgraduate</td>
</tr>
<tr>
<td>Semester</td>
<td>Summer</td>
</tr>
<tr>
<td>Workload in hours</td>
<td>Total: 150 / In-class: 60 / Self-study: 90</td>
</tr>
<tr>
<td>Lecturer</td>
<td>Prof. Dr. Andreas Kassler</td>
</tr>
</tbody>
</table>

Students acquire understanding and hands-on experience of how the data plane of modern datacenter networking equipment can be programmed using the high-level and popular programming language P4 (see http://p4.org). They learn the basic concepts of the P4 language and understand, how offloading simple computational tasks to the data plane of programmable networking devices (such as datacenter routers or network cards) can be used to speed up the performance of Deep Learning, Big Data Analytics use-cases within modern datacenters. They understand, how the data plane can be used to accelerate distributed high-performance computing (HPC) building blocks including distributed key-value stores, where load-balancing and network monitoring of the datacenter networking fabric is important for achieving high speed and low latency. They setup their own development environment in the network emulator Mininet and implement simple data plane programs in the P4 language. They know how to use P4 to parse packet headers, apply different actions and modify packets before forwarding them. They know basic P4 constructs, how to store stateful information (e.g. parts of a neural network) and how to perform simple computational tasks in the data plane.
Based on this knowledge and understanding, students implement a small-scale project in a team. They use their acquired knowledge on P4 and programmable datacenter networking. They evaluate the results of other project groups and get evaluated by other groups. For this project work, they have used standard tools (Mininet, P4 toolchain, command line interface) for programming the data plane of an (emulated) datacenter router. After finishing this module, students can design, implement and evaluate their own P4 programs using the network emulator Mininet.

The Course is decomposed into two parts:
Part I: “Introduction to Datacenter Network Programming” and Part II “Project in Datacenter Network Programming”

Content Part I:
(1) Introduction to Programming the Data Plane of a Datacenter networking device:
- Difference between Data and Control Plane
- Introduction to P4 language
- P4 programming model
- Compiling and deploying P4 programs
- P4 Targets: Behavioral Model (BMv2), Programmable Switching ASIC Intel Tofino, Mellanox Bluefield DPU, Netronome SmartNIC
- Basic P4 concepts: header parsing, applying tables and actions, header rewriting.
- Workshop: Setup Development environment with Mininet and Command Line Interface (CLI), implement, test and debug simple P4 language constructs and programs using the Mininet network emulator

(2) Datacenter Networking and Load Balancing:
- Datacenter networking fundamentals, routing and forwarding within the datacenter networking fabric
- Workshop: Advanced P4 concepts: stateful information, register arrays, counters and meters.
- Loadbalancing in Datacenter networks, Equal Cost Multipath Routing, Conga, Hula
- Workshop: Implementing ECMP in P4

(3) In Network support for Monitoring and Caching:
- Active and passive network monitoring
- Inband Network Telemetry (INT) for fine-granular network monitoring
- Accelerating Distributed Key-value stores in the data plane of the data center
- Using telemetry for fine-grained loadbalancing
- Workshop: Implementing Hula and INT in P4

(4) In Network support for Distributed Machine Learning:
- Role of the datacenter network for distributed training and inference
- In network support for Distributed Machine Learning Inference for in-switch traffic classification
- Mapping trained machine learning models (decision trees, SVMs, neural networks) to programmable data plane devices
- In network support for distributed training within a datacenter network

Content Part II:
Project: Implementation of your own small dataplane program in P4 and testing it in the Mininet network emulator.

<table>
<thead>
<tr>
<th><strong>Recommended literature</strong></th>
<th>Recommended Literature will be provided at the start of the course by a set of research and practical oriented articles that are available online.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Teaching methods</strong></td>
<td>Lecture with exercises and Labs followed by a small scale project</td>
</tr>
<tr>
<td><strong>Assessment method</strong></td>
<td>Written examination, 90 min.</td>
</tr>
<tr>
<td><strong>Language of instruction</strong></td>
<td>English</td>
</tr>
<tr>
<td><strong>Prerequisites</strong></td>
<td>Students should have basic understanding of Network Technologies and/or Communication Networks. Basic knowledge of Programming and basic knowledge in Python helps in the Project Part of the course.</td>
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</tbody>
</table>
Databases

<table>
<thead>
<tr>
<th>Course title</th>
<th>Databases</th>
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<tbody>
<tr>
<td>ECTS</td>
<td>5</td>
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<td>SWS</td>
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<tr>
<td>Course type</td>
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<td>Semester</td>
<td>Winter and summer</td>
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<tr>
<td>Workload in hours</td>
<td>In-class: 60 hrs. / Self-study: 90 hrs / Total: 150 hrs</td>
</tr>
<tr>
<td>Lecturer</td>
<td>Prof. Dr. Wolfgang Dorner / Prof. Dr.-Ing. Udo Garmann</td>
</tr>
</tbody>
</table>

Course objectives
- After this module students should
  - be able to describe the database design process,
  - know the elements of the Entity-Relationship-Model,
  - can build an Entity Relationship Model for a specific case,
  - can normalize a database design,
  - be able to manage a database through a database management system,
  - be able to query a database using SQL,
  - know the core components and functionalities of a database management system.

Recommended literature
- Conolly, Thomas M.; Begg, Carolyn E.: Database systems - A practical approach to design, implementation, and management. 4th edition. Addison-Wesley, an imprint of Pearson Education, 2005

Teaching methods
- Classes with exercises and practical training
- Course and document management through E-Learning System iLearn
<table>
<thead>
<tr>
<th><strong>Assessment method</strong></th>
<th>Written examination, 90 min.</th>
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</thead>
<tbody>
<tr>
<td><strong>Language of Instruction</strong></td>
<td>English</td>
</tr>
<tr>
<td><strong>Prerequisites</strong></td>
<td>Basics in Computer Science</td>
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# Advanced Programming Techniques

<table>
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<th>Advanced Programming Techniques</th>
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<td><strong>ECTS</strong></td>
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<td>Lecture</td>
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<tr>
<td><strong>SWS</strong></td>
<td>4 (2 SWS Lecture + 2 SWS Lab)</td>
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<tr>
<td><strong>Course level</strong></td>
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</tr>
<tr>
<td><strong>Semester</strong></td>
<td>Summer</td>
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<tr>
<td><strong>Workload in hours</strong></td>
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</tr>
<tr>
<td><strong>Lecturer</strong></td>
<td>Prof. Dr. Andreas Wölfl</td>
</tr>
</tbody>
</table>

**Course objectives**
The students advance their knowledge in computer programming with the goal to create and maintain complex software applications. By regular lab sessions, the students learn the interplay between design, implementation, operation and evolution of modern software in a hands-on manner.

**Course contents**
## Computer Science

### Recommended literature


### Teaching methods

Lecture with lab sessions

### Assessment method

Written examination, 90 min

### Language of instruction

English

### Prerequisites

Basic knowledge in object-oriented programming and operating systems.
## Advanced Topics in AI

<table>
<thead>
<tr>
<th>Course title</th>
<th>Advanced Topics in AI</th>
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<tbody>
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<td>Semester</td>
<td>Summer</td>
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<tr>
<td>Workload in hours</td>
<td>Time of attendance: 60 hours&lt;br&gt;Self-study: 90 hours&lt;br&gt;Total: 150 hours</td>
</tr>
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<td>Lecturer</td>
<td>Prof. Dr. Andreas Fischer</td>
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</tbody>
</table>

### Course objectives
The purpose of this course is to provide students with hands-on and real-world development experience. They will have the opportunity to review some cutting-edge research papers and to then turn them in concrete software/hardware outcomes. As these projects are completed in teams, students will also have the opportunity to elaborate on their social and language skills. At the end of the term, students will present their projects at an in-house R&D fair which will be open to the public.

### Course contents
- Implementing contemporary research papers from the fields of artificial intelligence, machine learning, computer vision, natural language processing and others.
- Using modern high-end hardware, such as GPUs clusters and cloud services.
- Utilizing an agile process framework such as Scrum.
- Understanding and using modern industrial software development tools such as work package trackers, code revision systems, debuggers, profilers and others.
Presenting R&D outcomes to stakeholders at different levels, such as fellow students, faculty members and practitioners and executives.

<table>
<thead>
<tr>
<th>Recommended literature</th>
<th>Basic:</th>
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<tbody>
<tr>
<td>Study aids:</td>
<td></td>
</tr>
<tr>
<td>- High-end GPUs</td>
<td></td>
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<td>- Cloud services</td>
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<td>- Development boards</td>
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<td>- Mobile robots and drones</td>
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<td>- Hardware manuals</td>
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</table>

<table>
<thead>
<tr>
<th>Teaching methods</th>
<th>project and seminars</th>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Assessment method</th>
<th>written student research project</th>
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<table>
<thead>
<tr>
<th>Language of instruction</th>
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</table>

<table>
<thead>
<tr>
<th>Prerequisites</th>
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</thead>
</table>
# Informatics II

<table>
<thead>
<tr>
<th><strong>Course title</strong></th>
<th>Informatics II - Contemporary Usage of Python</th>
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<tbody>
<tr>
<td><strong>ECTS</strong></td>
<td>5</td>
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</tr>
<tr>
<td><strong>SWS</strong></td>
<td>4</td>
</tr>
<tr>
<td><strong>Course level</strong></td>
<td>Postgraduate</td>
</tr>
<tr>
<td><strong>Semester</strong></td>
<td>Summer</td>
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</tbody>
</table>
| **Workload in hours** | Time of attendance: 60 hours  
self-study: 45 hours  
virtual learning: 45 hours  
Total: 150 hours |
| **Lecturer**     | Prof. Dr. Gökçe Aydos                       |

The purpose of the course is to learn to:

**Professional competences:**

- outline fundamental features of the Python programming language
- understand the advantages of object-oriented and functional programming
- know different request types to access web resources
- list useful libraries from the standard library

**Course objectives**

**Methodological competences:**

- implement programs for string processing
- leverage the interactive interpreter for short computing tasks
- use object-oriented programming to breakdown a program into classes
- use functional programming to write shorter code
- implement programs for interacting with web APIs
- carry out simple image processing tasks
- leverage Numpy to conveniently work with matrices
- use an unknown library by reading its documentation

**Social competences**

- cooperate in a pair programming setting
- evaluate someone else’s work and give constructive feedback (e.g., in context of peer-assessed exercises)

Most of the contents are based on the course **CS41: The Python Programming Language** from Stanford University.

**Course contents**

- **Python basics:**
  - Interactive interpreter
  - Comments
  - Variables and types
  - Numbers and Booleans
  - Strings and lists
  - Console I/O
  - Control Flow
  - Loops
  - Functions
  - Assignment Expressions

- **Data structures:**
  - list
  - dict
  - tuple
  - set

- **Object-oriented Python:**
  - errors and exceptions
    - *easier to ask for forgiveness than permission* (EAFP) vs *look before you leap* (LBYL)
  - data model
  - classes
  - exceptions as classes

- **Functions:**
  - namespaces and scope
  - Python Functions
  - (variadic) arguments
  - Parameter ordering

- **Functional programming:**
  - meaning
  - first-class functions
  - lambdas
  - iterators and generators
  - map and filter
  - decorators
- Python & the Web:
  o HTTP
  o requests library
  o working with images
  o creating a web interface for your app using Flask library
- Numpy:
  o what is a matrix?
  o why are matrices useful?
  o n-dimensional array ndarray
  o axes and shapes
  o matrix operations
  o statistical methods
  o parameter fitting example
- Standard library and third-party libraries

**Recommended literature**

- Lecture videos in DIT’s Moodle
  o alternatively: Stanfordpython course reader
- Slides that accompany the videos. These are tailored for discussions during the class.
- Exercise notebooks in DIT’s Moodle
- Previous Exams
  o Instructor versions
  o Student versions

**Teaching methods**

- Flipped classroom
- Labs with feedback sessions
- Pair programming

**Assessment method**

Written examination, 90 min.

**Language of instruction**

English

**Prerequisites**

- Computer science fundamentals (e.g., information, hardware, software, operating systems, shells, algorithms)
- Fundamental programming tools (e.g., control flow, data structures, functions)
FPGA Programming

<table>
<thead>
<tr>
<th>Course title</th>
<th>FPGA Programming - Digital Circuit Design Using Systemverilog</th>
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</thead>
<tbody>
<tr>
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</tr>
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<td>SWS</td>
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<td>Prof. Dr. Prof. Dr.-Ing. Gökçe Aydos</td>
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</table>

The purpose of the course is to learn to:

- explain the typical structure of FPGAs
- differentiate a hardware description language from a typical programming language, e.g., regarding structure and purpose
- use Systemverilog and a state-of-the-art FPGA development tool to develop circuits on an FPGA
- differentiate between structural and behavioral design approaches
- analyze behavioral description and write code that implement the behavior
- classify which data processing tasks are better suited for FPGAs than general processors
- cooperate in a pair programming setting
- evaluate someone else’s work and give constructive feedback (e.g., in context of peer-assessed exercises)

Course objectives

Course contents

- Getting started with the FPGA board
- Implementation (including testing using testbenches) of:
  - combinational logic, e.g., multiplexer, decoder, shifter, encoder
  - sequential logic, e.g., flip-flop, latch, counter, memory
  - arithmetic circuits, e.g., adder, multiplier
### Computer Science

- state machines
- a digital system: reaction time monitor

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#### Recommended literature

- Digital logic course by Realdigital
  - Lecture videos related to the content can be found in the section *Lectures* on EE214 course page from Washington State University
- Accompanying lecture notes: Digital logic notes
- Realdigital Boolean FPGA board will be provided by the instructor that you may use during the class. It is not possible to borrow a board for home. If you want to work at home, please buy one.

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#### Teaching methods

To reach the learning outcomes we will use the following didactic methods:

- Flipped classroom
- Labs with feedback sessions and pair programming

During the labs you are encouraged to work with a partner in a pair programming setting. Your partner and the instructor will give you feedback.

- Mini projects on the FPGA

Every week there will be problems that you must solve on an FPGA board.

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#### Assessment method

Written examination, 90 min.

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#### Language of instruction

English

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#### Prerequisites

- Fundamental programming tools (e.g., control flow, data structures, functions)
- Digital logic (e.g., transistor, logic gate, K-map, SOP, POS, multiplexer, counter)

The learning materials contain a graceful introduction to digital logic so you can still attend the course if you do not have any experience with digital logic. But expect more workload in this case.