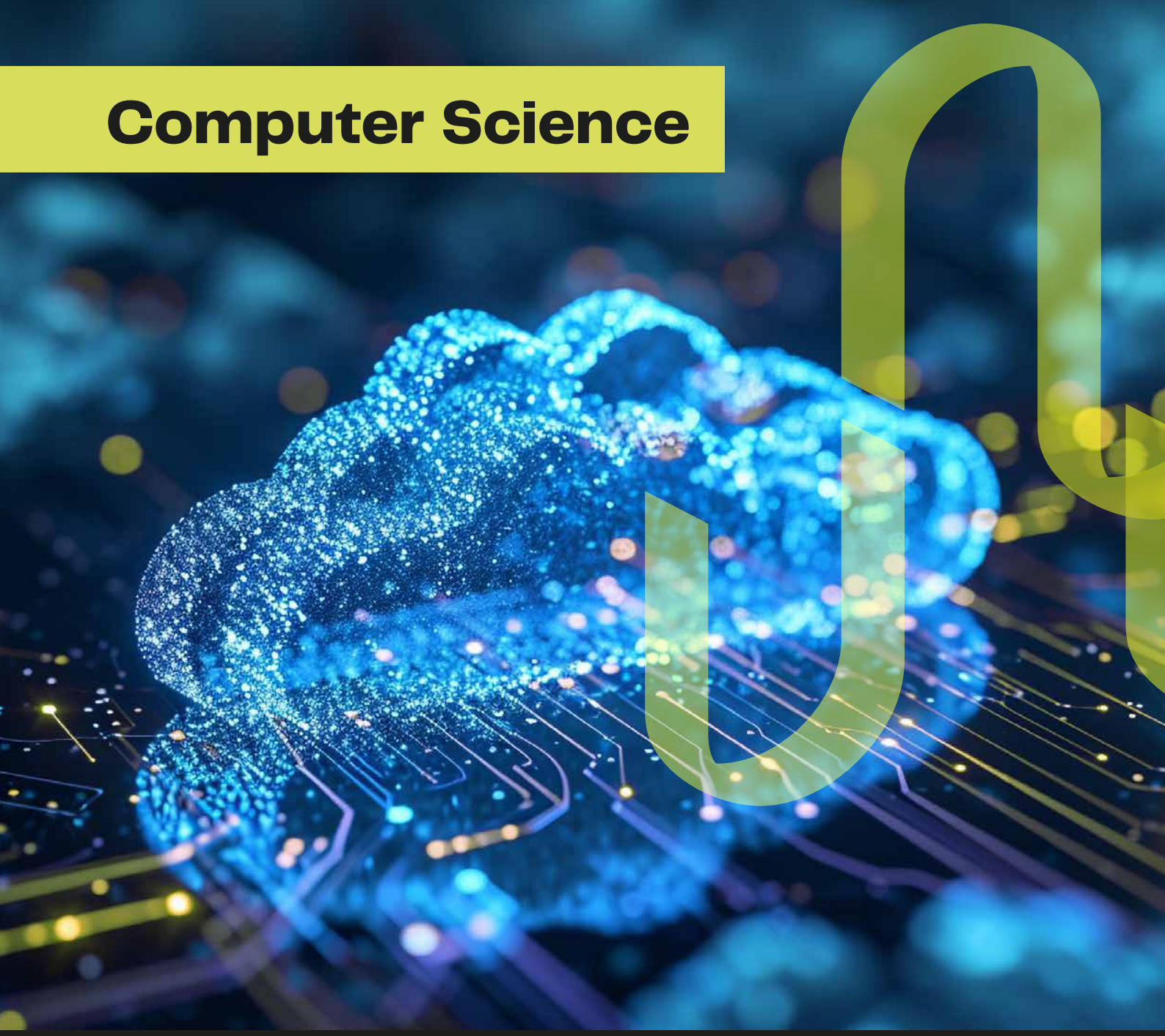
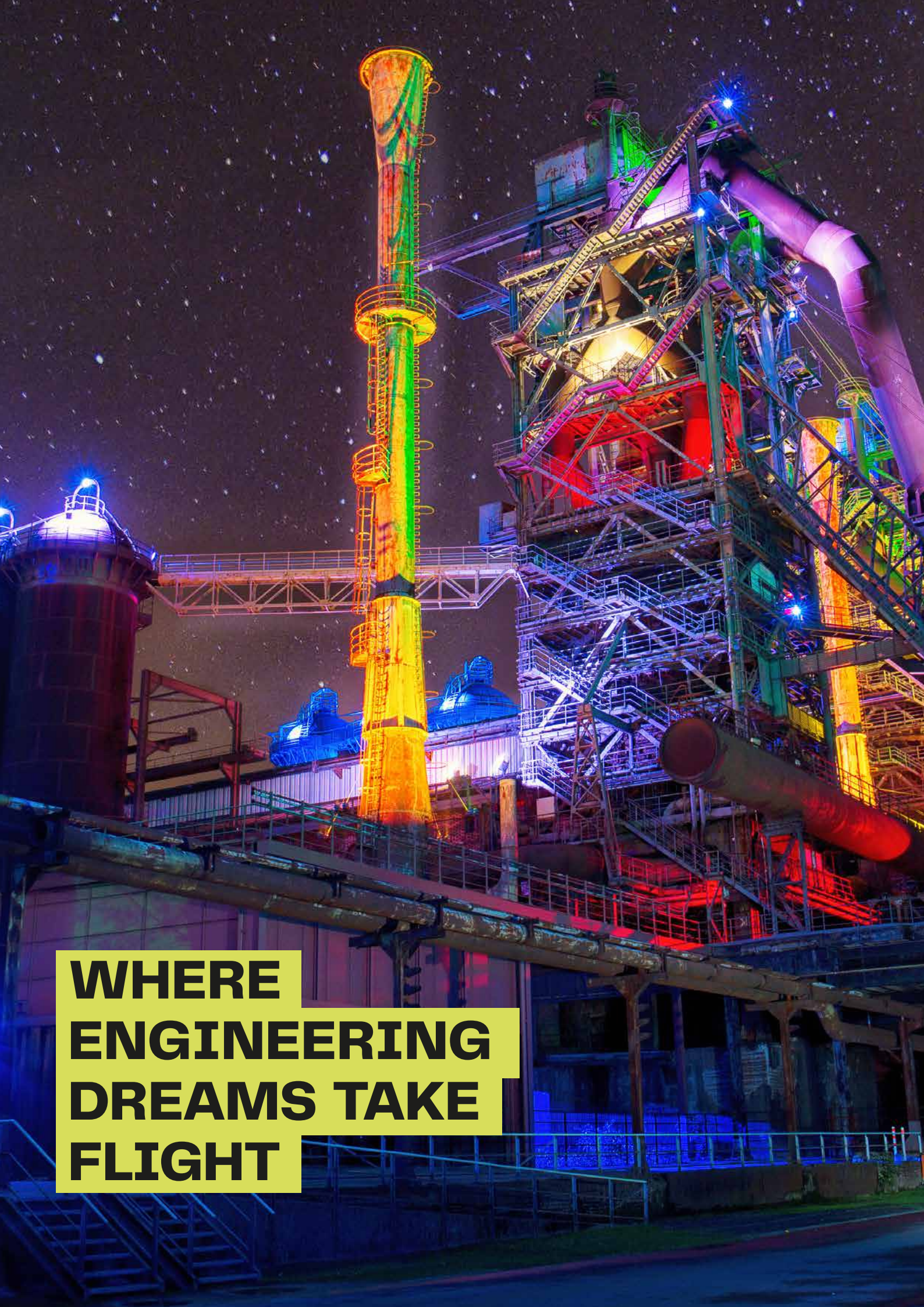
Computer Science



MODULE MANUAL

SUMMER SEMESTER 2025



WHERE ENGINEERING DREAMS TAKE FLIGHT

Discover the Heartbeat of German Industry

Welcome to the 30 ECTS Program for computer scientists in English language at Bochum University of Applied Sciences, Fachhochschule Dortmund – University of Applied Sciences and Arts, and the Westphalian University of Applied Sciences. The program is open to international undergraduate students, offering an insight into the expertise in computer science on a bachelor level at the three participating universities. It grants an overall unique international experience.

Overview

Preliminary Remarks

How to study at three reputable German universities of applied sciences?

When you are a student of the 30 ECTS Program for international incomings, you get the opportunity to study not at one but at three reputable German universities of applied sciences. While you enroll at one of the three universities as an incoming international student, it is necessary to register as a cross-registered student as well to be able to attend the modules at all three universities and thus benefitting from the broader selection of elective modules in English. You will receive detailed instructions on how to enroll as a secondary student at the other two universities. The process is fully digital and simple. No worries. Enrolling as a cross-registered student at the other two universities is free of charge for you.

Exams

Your exam achievements from the other two universities will be recognized by your host university as all three are part of the Higher Education Alliance Ruhr. You will receive detailed guidance on the enrolling process once you have enrolled at your guest university.

Module manual and workload

To prepare your learning agreement, the present module manual gives you the entire choice of courses from the 30 ECTS Program of all three alliance universities. Please be aware that the workload and therefore the number of ECTS for a module might vary according to the requirement of your host university. Please note that a course can only take place if enough students take part.

If you have questions concerning the number of ECTS, please do not hesitate to contact us:

→ study@hochschulallianz.ruhr

Details can be discussed individually.

Please be aware that all information is subject to possible changes.

Program locations

The courses of the 30 ECTS Program take place at the university campuses in Dortmund and in Bochum as well as at the two locations of the Westphalian University of Applied Sciences in Gelsenkirchen and in Bocholt. All modules in this manual are in-class lectures requiring a physical presence of the students at the respective campus. Depending on your choice of modules, you will be required to commute between the universities accordingly. Please become familiar with the locations of Fachhochschule Dortmund - University of Applied Sciences and Arts, Bochum University of Applied Sciences, and the campuses of the Westphalian University of Applied Sciences in Gelsenkirchen and in Bocholt. We will also give you more information on the different locations in an onboarding session.

Please make sure to calculate enough time between the seminars on the different campuses. (The commute with public transportation can vary from one hour between the campuses in Bochum and Dortmund up to two and a half hours to Bocholt from Bochum or Dortmund and vice versa). Your semester ticket allows you to shuttle at no extra costs and you have a sustainable journey between the different cities.

Exploring public transportation as an international student

Mobility in Metropolitan Area Ruhr

HIGHER EDUCATION ALLIANCE RUHR

What is the Higher Education Alliance Ruhr?

The 30 ECTS Program for international exchange students is an offer of the Higher Education Alliance Ruhr. The Higher Education Alliance Ruhr is a consortium of Universities of Applied Sciences in the Ruhr area consisting of Bochum University of Applied Sciences, Fachhochschule Dortmund - University of Applied Sciences and Arts, and the Westphalian University of Applied Sciences. They cooperate in various fields, seeking to strengthen their international visibility, their networking and exchange opportunities as well as the mobility of their students, lecturers, researchers, and staff. The goal of the university alliance is to promote cross-border, intercultural exchange as well as international competences to prepare students for an international career.

The Higher Education Alliance Ruhr enables students to choose from a broader range of offers, to set an individual focus in their studies and to look beyond their own horizons.

Contact information

Program coordinator:

For further information about our 30 ECTS program, please contact our program coordinator. Feel free to schedule a video call.

study@hochschulallianz.ruhr

APPLIED NETWORK SECURITY

Westphalian University of Applied Sciences, Campus: Gelsenkirchen

ECTS	Workload	Study Semester	Duration	Frequency
6	180 h		One Semester	
Courses		**Attendence Time**	**Self-Study**	**Group Size**
2 h lectures | 2 h practical work (i.e. labs) (per semester week)		56 h	124 h	

Learning outcomes/Objectives

Students understand various attack vectors and corresponding protection mechanisms in modern networks. Specifically, students have knowledge and understanding of the following topics.

- Understanding of basic concepts and principles of network security, including threats, attack methods and protection options.
- Knowledge of common network attacks such as Distributed Denial-of-Service (DDoS), Man-in-the-Middle (MitM), spoofing, and others.
- Understanding of security protocols and technologies for mitigating attack vectors and reducing attack surfaces.
- Assessment of IT security risks in networks and of various attack vectors

Contents

Basics
- Network architectures and concepts: TCP/IP and ISO/OSI reference model, common protocols, network architectures.
- Network security: Introduction, threats, challenges.
- Analysis of network traffic: Capturing and reading network traffic, common tools and data formats for reading, advantages and limitations of different approaches

Security at the Internet and network access layer
- Attacks at MAC and IP level: ARP poisoning, MAC spoofing, ICMP flooding, network scanners.
- Security of wireless networks: encryption (WPA3), MAC address filtering and hiding of SSIDs, Evil Twin attacks, man-in-the-middle attacks

Security at the transport level
- Attacks on TCP and UDP: port scanning, TCP session hijacking, UDP flooding and reflection attacks.
- Protocols for encryption: Transport Layer Security (TLS) and Datagram Transport Layer Security (DTLS)

Security at the application level
- Security of web applications: Cross-site request forgery (CSRF) and cross-site scripting (XSS), HTTP security mechanisms (e.g. content security policies), command and SQL injections.
- DNS security: DNS spoofing, DNSSEC, DNS tunneling, DNS amplification attacks
- Email security: SPAM detection, email encryption, phishing

Teaching Methods

Lecture, Practical training

Requirements for taking the exam

None

Lecturer

Prof. Dr. Tobias Urban

Additional Information:

The current literature, the forms of examination as well as the requirements for the award of credits will be announced by the lecturer at the beginning of the module.

COMMUNICATION AND COMPUTER NETWORKS

Fachhochschule Dortmund – University of Applied Sciences and Arts

ECTS	Workload	Study Semester	Duration	Frequency
5	150 h	4th semester / Bachelor	One semester	Summer semester

Courses	Attendence Time	Self-Study	Group Size
2 h lectures | 1 h exercises | 1 h practicals (per semester week)	60 h	90 h	

Learning outcomes/Objectives

Professional and methodological competence

After completing the course, students will be able to

- Understand the principles, protocols and architecture of local networks and the internet
- Use elementary commands of the Linux, macOS and Windows operating systems for network configuration and network testing
- Perform and interpret protocol and network analyses with analysis tools
- Analyse existing wired and wireless networks
- Analyse captured network traffic
- Design and realise wired and wireless networks
- Configure network components (router, switch) including VLAN and NAT

Contents

- OSI and TCP/IP model
- Networking fundamentals
- Network devices (Hub, Switch, Router)
- Physical Layer, transmission media
- Data Link Layer and Ethernet
- Network Layer, IPv4, IPv6, Routing, NAT
- Transport Layer, UDP, TCP, QUIC
- Application Layer, HTTP(s), DNS, DHCP
- Wireless communication
- Wireshark, GNS3

Teaching Methods

- Lecture in interaction with the students, with writing on the blackboard and projection
- Exercise accompanying the lecture
- Working on programming tasks on the computer in individual or team work

Participation Requirements (Prerequisites/ Eligibility)

Passed written examination

Requirements for taking the exam

None

Module Coordinator	Lecturer
Prof. Dr. Daniel Spiekermann	Prof. Dr. Daniel Spiekermann

Additional Information:

- Andrew S. Tanenbaum, David J. Wetherall; Computer Networks; Pearson Studium; 6th edition; 2021
- Douglas E. Comer, Ralph Droms; Computer Networks and the Internet; Pearson Studium; 6th edition; 2013
- Laura Chappell, Gerald Combs, 2017; Wireshark 101: Essential Skills for Network Analysis - Second Edition; Wireshark Solution Series (English Edition)

COMPUTER GRAPHICS

Westphalian University of Applied Sciences, Campus: Bocholt

ECTS	Workload	Study Semester	Duration	Frequency
6	10 h		One semester	
Courses		**Attendence Time**	**Self-Study**	**Group Size**
2 h lecture | 2 h practical training (per semester week)				

Learning outcomes/Objectives

You will be familiar with and understand the fundamental methods of computer graphics and confidently apply these in your own interactive programs. In small groups, you will be able to develop your own ideas for an interactive graphics application and, building on the knowledge gained, create solutions for its successful implementation. To this end, you will independently research additional methods and techniques to integrate them into your application. You will be able to effectively communicate your results.

Contents

Lecture:
- Colours
- Basic rasterisation methods
- Representation and modelling of objects and scenes
- Object and view transformations in two- and three-dimensional space
- Projections
- Local illumination models, modelling of surface properties
- Basic animation techniques
- Design and requirements of interactive real-time applications

Practical / Project Work:
- Implementation of small 3D applications based on lecture content using a standard graphics library or engine (e.g. OpenGL, Unity, Unreal)
- Development and implementation of advanced methods (e.g. kinematics, physics, global illumination, photorealistic rendering)
- Scene modelling using state-of-the-art tools (e.g. Autodesk Maya)
- Planning, development, and implementation of a simple interactive graphics application in small groups to demonstrate and explore the methods covered

Teaching Methods

Lecture, Practical / Project work

Requirements for taking the exam

None

Lecturer

Prof. Dr. Tom Vierjahn

Additional Information:

The current literature, the forms of examination as well as the requirements for the award of credits will be announced by the lecturer at the beginning of the module.

GERMAN AS A FOREIGN LANGUAGE: BASIC COURSE

Westphalian University of Applied Sciences, Campus: Gelsenkirchen

ECTS	Workload	Study Semester	Duration	Frequency
5	150 h		One semester	Every semester

Courses	Attendence Time	Self-Study	Group Size
German as a Foreign Language: Basic Course (Beginners)	60h	90h	Max 30 students

Learning outcomes/Objectives

Communicative and cultural competence in the German language on a basic level

Contents

Introduction to the basic structures of the German language:
The course offers an introduction to German as a foreign language for beginners. It will cover basic vocabulary and grammar needed in everyday situations and academic settings. Cultural aspects related to the respective topics will be addressed throughout the course.

Following a blended-learning approach, the course will be completed by digital content.

Teaching Methods

Seminar and others

Participation Requirements (Prerequisites/ Eligibility)	Requirements for award of ECTS points
None	At least 50% (50/100 pts)
Forms of examination (Type)	**Requirements for taking the exam**
Written exam (120 min); no aids (e.g., dictionaries) permitted	None
Module Coordinator	**Lecturer**
The Language Centre	Julia Brassat, Dr. Tobias Budke et al. (Language Centre – Sprachenzentrum)

Additional Information:

The course will include the systematic use of classic and interactive media in the classroom and in the Language Centre's multi-media lab.

INTRODUCTION TO ROBOTICS

Westphalian University of Applied Sciences, Campus: Gelsenkirchen

ECTS	Workload	Study Semester	Duration	Frequency
6	180 h	4th semester / Bachelor	One semester	Summer semester

Courses	Attendence Time	Self-Study	Group Size
2 h lecture | 3 h practical work and exercise session (lab time) (per semester week)	70 h	110 h	

Learning outcomes/Objectives

Students learn the basics, components and terminology of industrial robots and collaborative robots. They learn programming concepts and methods and can use these effectively and in a structured manner when developing their own control programs. They are familiar with the dangers and challenges of using industrial robots and understand the importance of complying with regulations. In addition to the programming methodology, students learn how to use libraries of the robot framework ROS2 (Robot Operation System).

Contents

- Fundamentals of industrial robotics / manipulator technology, collaborative robots
- Conceptualization and components
- Description of a robot position
- Transformation between robot and world coordinates
- Kinematic (Denavit-Hartenberg-Transformation)
- Inverse kinematic (Mathematical, Jacobian matrix, Neural Networks)
- Robot programming
- Robot framework ROS2
- Motion type and interpolation
- Operating system: Linux + ROS2; teaching languages are C / C++, Python, ipython notebooks
- Robots for lab exercises: Franka Arm, Kuka

Teaching Methods

Lecture, Practical work and exercise sessions (lab time)

Requirements for taking the exam

None

Lecturer

Prof. Dr. Hartmut Surmann

Additional Information:

The current literature, the forms of examination as well as the requirements for the award of credits will be announced by the lecturer at the beginning of the module.

OBJECT-ORIENTED PROGRAMMING IN C++

Westphalian University of Applied Sciences, Campus: Gelsenkirchen

ECTS	Workload	Study Semester	Duration	Frequency
6	180 h		One semester	
Courses		**Attendence Time**	**Self-Study**	**Group Size**
2 h lecture | 1 h practical work | 1 h exercise session (per semester week)		56 h	124 h	

Learning outcomes/Objectives

- Understanding of the concepts of object-oriented programming in C++
- Confident handling of the syntax of C++, especially pointers and references
- Understanding operator overloading, especially in connection with containers
- Practiced handling of templates and corresponding libraries

Contents

- Syntax extensions compared to C
- Conceptual differences compared to JAVA
- Default and copy constructors, initialization list
- Operator overloading
- Inheritance and multiple inheritance
- Templates, containers and iterators
- Working with the standard template library
- Advanced template applications
- Exception handling in C++

Teaching Methods

Lecture, Practical work and exercise sessions

Requirements for taking the exam

None

Lecturer

Dr. Pedro Novo

Additional Information:

The current literature, the forms of examination as well as the requirements for the award of credits will be announced by the lecturer at the beginning of the module.

PARALLEL PROGRAMMING

Westphalian University of Applied Sciences, Campus: Gelsenkirchen

ECTS	Workload	Study Semester	Duration	Frequency
6	180 h	4th semester / Bachelor	One semester	Summer semester

Courses	Attendence Time	Self-Study	Group Size
2 h lecture | 3 h practical work and exercise session (lab time) (per semester week)	70 h	110 h	

Learning outcomes/Objectives

Students learn the basics and concepts of parallel programming and the parallel programming paradigm and are able to develop and test parallel programs. They learn to parallelize sequential algorithms and to distribute them in parallel within the graphics card or multi-core architectures or across several computers. In addition to programming methodology, parallel patterns and design, students learn about the special problems and issues involved in parallel programming, in particular the recognition of concurrency and the more difficult error analysis.

Contents

- Basics of parallel programming
- Parallel architectures
- Design and analysis of parallel algorithms
- Threads
- OpenMP
- MPI
- OpenCL
- CUDA
- Parallel patterns (Map, Reduce, Scan, Sort, Neural Networks, ...)
- Operating system: Linux; teaching languages are C / C++, Python, ipython notebooks

Teaching Methods

Lecture, Practical work and exercise sessions (lab time)

Requirements for taking the exam

None

Lecturer

Prof. Dr. Hartmut Surmann

Additional Information:

The current literature, the forms of examination as well as the requirements for the award of credits will be announced by the lecturer at the beginning of the module.

PRACTICAL SECURITY ATTACKS AND EXPLOITATION

Westphalian University of Applied Sciences, Campus: Gelsenkirchen

ECTS	Workload	Study Semester	Duration	Frequency
6	180 h	4th semester / Bachelor	One semester	Summer semester
Courses		**Attendence Time**	**Self-Study**	**Group Size**
1 h lecture | 3 h practical work (per semester week)		56 h	124 h	

Learning outcomes/Objectives

- Understand common procedures for system security, system integrity and software protection
- Apply mechanisms to identify and exploit software vulnerabilities
- Apply attack techniques in computer networks
- Acquire knowledge in the field of malware detection and defense
- Participate in a capture-the-flag competition

Contents

Students learn the applicability and limitations of security-related attacks against systems, network protocols and software.
The following topics are covered:

- Linux and Unix-like operating system basics
- Vulnerability research
- Reconnaissance and scanning
- System security and operational security
- Software security
- Bytecode and binary code analysis
- Denial-of-service attacks
- Web security
- Incident response

Each course unit consists of an introduction in the form of at least one lecture unit and task that have to be solved in the practical course. In addition, students must design their own vulnerable examples as tasks that could be used, for example, as part of their own CTF competition.

Teaching Methods

Lecture, Practical work

Requirements for taking the exam

None

Lecturer

Prof. Dr. Christian Dietrich

Additional Information:

The current literature, the forms of examination as well as the requirements for the award of credits will be announced by the lecturer at the beginning of the module.

PROJECT WORK

Fachhochschule Dortmund – University of Applied Sciences and Arts

ECTS	Workload	Study Semester	Duration	Frequency
15	450 h	5th / 6th semester / Bachelor	One semester	Every semester
Courses		**Attendence Time**	**Self-Study**	**Group Size**

Learning outcomes/Objectives

Through the project work, students learn the following skills, which prepare them to write their final thesis and qualify them for their career entry:

Expertise and methodological skills
- Solving IT-specific problems, if possible in a business context, by creating a software/hardware solution in an engineering manner (i.e. specifying requirements, weighing up and evaluating alternative solutions, modelling systems and ensuring quality), taking limited resources into account.

Interdisciplinary methodological competence
- Carrying out the work as a project (i.e. setting objectives and planning projects, pre- and post-calculation of the time required), and
- Preparation of the written paper using scientific working methods (e.g. literature research, correct citation).

Self-competence
- Assessing one‘s own work results.

Social competence
- Ability to work in a team with developers and (as far as possible) users, especially: to present work results, to lead and moderate meetings and to resolve conflicts.

Occupational field orientation
- Work on practically relevant tasks.

Contents

The content of a project paper is assessed according to effort and complexity, originality and independence, scientific working technique and methodological approach, practical realisation, style and external form.

Students have the right to suggest a project topic. The specific knowledge directly required in the projects will be taught in block courses if necessary.
Regular project meetings give students the opportunity to acquire the above-mentioned teamwork skills through practice. In particular, quality assurance is practised through the presentation of results from analysis, design and implementation.

Teaching Methods

Project work; final presentation

Participation Requirements (Prerequisites/ Eligibility)	**Requirements for award of ECTS points**
Project work with oral examination	Successful project work
Requirements for taking the exam	
None	
Module Coordinator	**Lecturer**
Prof. Dr. Sonja Kuhnt; all professors	Prof. Dr. Sonja Kuhnt; all professors

STATISTICS

Fachhochschule Dortmund – University of Applied Sciences and Arts

ECTS	Workload	Study Semester	Duration	Frequency
5	150 h	2nd / 3rd semester / Bachelor	One semester	Every semester

Courses	Attendence Time	Self-Study	Group Size
2 h lectures | 2 h exercises (per semester week)	60 h	90 h	

Learning outcomes/Objectives

Acquisition of basic knowledge of applied statistics and the ability to select and apply descriptive and inductive statistical methods to solve practical problems.

Expertise and methodological skills
- Acquisition of methodological basics of descriptive and inferential statistics
- Describing essential structures in data by selecting suitable descriptive methods
- Converting problems into random variables and suitable distribution assumptions
- Drawing inferences from samples to populations using parameter and interval estimation
- Formulation of test problems and independent implementation of hypothesis tests
- Initial experience with the computer-aided analysis of data

Interdisciplinary methodological expertise
- Supporting decision-making processes through descriptive and inferential data analysis
- Transferring estimation and test procedures to problems in computer science
- Applying statistical methods in connection with the evaluation of databases
- Simulation of stochastic processes with the help of theoretical distributions
- Deriving predictions with the help of statistical estimation methods

Contents

- Populations and Samples
- Frequency Distributions and Histograms
- Descriptive Summary Measures
- Relationships between Variables
- Probability
- Random Variables
- Confidence Intervals
- Hypothesis Testing
- Simple Linear Regression

Teaching Methods

- Lecture in interaction with the students, with blackboard writing and projection
- Solving practical exercises in individual or team work
- Working on programming tasks on the computer in individual or team work
- Active, self-directed learning through internet-supported tasks, sample solutions and accompanying materials

Forms of examination (Type)	Requirements for taking the exam
Written examination Coursework during the semester (bonus points)	None

Module Coordinator	Lecturer
Prof. Dr. Sonja Kuhnt	Prof. Dr. Sonja Kuhnt

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