Fachhochschule Dortmund
University of Applied Sciences and Arts

Faculty of Computer Science

MODULE HANDBOOK

for the study program
Master Medical Informatics
(Examinationversion 2026)

status: June 15, 2026

TABLE OF CONTENTS

Number	Titel
41021	Scientific & Transversal Skills 1

Language	Duration	Semester	Frequency of offer	Type of module	CP
english	1 Sem.	1	Winter semester only	Compulsory	6

1	Events	Type of event	Planned group size	Workload		HPW
				Contact-hours	Self-study	
			25	60 h	120 h	4
-	Scientific and Transversal Skills 1	Lecture	60			2
-	Scientific and Transversal Skills 1	Exercise	20			2

2 Learning Outcomes / Competencies

Knowledge:
Upon completion of this module, students will be able to:
- know research methods and tools of medical informatics (scientific) domain
- know and understand the culture of different partner countries
- know programming languages and modelling techniques
- know web development techniques, languages, tools and frameworks
- have IT literacy in tools like MS Excel, Word and Powerpoint
- know German vocabulary and grammar at least on A1 level
- know English vocabulary and grammar at least on C1 level
- know basic terminology of medical informatics

Application and generation of knowledge: The students are able to:
- apply research methods and tools of the scientific domain
- work in international and intercultural settings
- can program software in Java (alternative: C# or Python)
- can model systems in UML
- can develop basic applications
- use tools like MS Excel, Word and Powerpoint proficiently
- speak, understand, read and write German at least on A1 level
- speak, understand, read and write English at least on C1 level

Communication and cooperation:
- Students can cooperate in a cross-border project with international students
- Students can adapt and to cope with different European cultures
- Students learn to communicate with people from different countries

Scientific self-understanding / professionalism:
- Students can plan and conduct scientific research in their field
- Students are aware of their own cultural background and can interact with other cultural background adequately

3 Course Description and Course Structure

The module provides a set of several smaller training units to the students where they can choose in order to fill gaps from previous studies or add specific competences. Up to 10 courses are offered in the winter term (according to availability). The intercultural training (see list below, No. 1) is mandatory for all students and will be offered every semester. Students have to choose 3 out of 6 optional training units (from No. 2-7+10). For students without at least German A1, the German course (No. 8) is mandatory. For German native speakers, another language course has to be concluded at least on A1 level (No. 9). To fill gaps in medical informatics a refresher is given (No. 10). More courses can be added according to the analysis of the needs: Course Structure In the initial set up of the master a selection of 8 compact courses are offered. More can be added according to the analysis of the needs of actual students:

	1. Intercultural Training (ICT): The intercultural training is intended to help the students to interact and work successfully with their teachers and peers at the university. It is conducted also as a team building event for the new class in the first semester. It should also motivate students for a later mobility/exchange with the partner universities. 2. Compact Web Development Course (online): This course delivers the basics of web programming languages and frameworks. It is intended for catch up for students with only very limited web development skills. 3. Compact Programming Course (Java, alternatives: C# or Python): This course delivers object-oriented programming skills in Java (decision is made prior to semester start, can be switched to C# or Python depending in the language used in the 1st semester). It is intended for catch up for students with limited programming skills. 4. Modeling of Software Systems (UML): This course delivers object-oriented modeling skills in UML. It is intended for catch up for students with limited software and systems engineering skills. 5. Research Methods and Tools – part A (RMT-A): Introduction to scientific methods and tools in the digital transformation domain. Furthermore, analysis of relevant scientific trends and communities. Students can prepare for scientific work via the sequence of RMT-A and RMT-B plus a Research Seminar. 6. Cross-Border Project A: During the November Master block week or a workshop at a partner university, projects with teams of students from several partners are formed. They conduct projects, e.g. on industry cases and present the results, e.g. in pitching. 7. ICDL-Excel: students who lack relevant IT skills can take part in the preparation courses for the International Computer Driver License (ICDL) at FH Dortmund and do the respective exams. The Excel course puts the focus on using Excel for data analytics and business intelligence. 8. International Project Communication 1 e (German A1): A language certificate of German at least on level A1 has to be provided at the end of the semester. Respective courses are organized and embedded into the weekly schedule. 9. International Project Communication 1 g (other language): For students with native German background (e.g. German/Austrian/Swiss citizens or students with a prior degree taught in German (e.g. “Bildungsinländer”), a language certificate in an additional language (e.g. French, Spanish, Chinese, etc.) at least on A1 level is required. In case of an English language certificate, C2 level is needed 10. Introduction to Medical Informatics Terminology and Standards.
4	**Teaching Methods** 1. Intercultural Training (ICT): lectures and role plays 2. Compact Web Development Course: online, set of LinkedIn courses with tests 3. Compact Programming Course: online courses, programming tasks with reviews 4. Modeling of Software Systems (UML): lectures, exercises and written exam 5. Research Methods and Tools – part A (RMT-A): lecture 6. Cross-Border Project A: project and presentation 7. ICDL Excel: methods & tool training 8. International Project Communication 1 e (German A1): language training 9. International Project Communication 1 g (other language A1 or English C2): language training 10. Medical informatics refresher
5	**Participation Requirements** None
6	**Examination Forms** 1. Intercultural Training (ICT): exam

	2. Compact Web Development Course: online tests (LinkedIn) 3. Compact Programming Course: review of the programming tasks, related questions 4. Modeling of Software Systems (UML): written exam 5. Research Methods and Tools – part A (RMT-A): homework (paper assignment) 6. Cross-Border Project A: presentation and discussion 7. ICDL Excel: test 8. International Project Communication 1 e (German A1): language test 9. International Project Communication 1 g (other language A1 or English C2): language test 10. Medical informatics refresher: exam
7	**Requirements for the award of credit points** Successful completion of course Nr. 1, and 3 out of 7 technical courses (Nr. 2-7+10, graded), and language certificate (8 or 9). The weight for the mark of the graded courses is 1/3.
8	**Significance of the grade for the final grade** 5,00%
9	**Module Representative** Prof. Dr.-Ing. Christoph M. Friedrich **Lecturer** see current course catalog or individual study plan in the Portal of the University of Applied Sciences and Arts Dortmund
10	**Literature** Loy, M., Niemeyer, P., Leuck, D. (2023). Learning Java: An Introduction to Real-World Programming with Java, 6th Edition, O-Reilly Media. Miles, R., Hamilton, K. (2006). Learning UML 2.0: A Pragmatic Introduction to UML 1st Edition, O-Reilly Media. Dresch, A., Pacheco Lacerda, D., & Valle Antunes Jr., J. A. (2015). Design Science Research: A Method for Science and Technology Advancement. Springer International Publishing Switzerland. Bailey, S. (2018). Academic Writing – A Handbook for International Students (5th ed.). Routledge, New York. Saunders, M., Lewis, P., Thornhill, A. (2019). Research Methods for Business Students, 8th edition, Pearson. Bryman, A., Bell, E. (2011). Business research methods, 3rd Edition, Oxford University Press. Creswell, J.Q. (2022). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 6th edition, Sage Publications. Mayring, P. (2021). Qualitative content analysis, Sage Publications, 1st Edition. Jordan, C. (2022). ICDL Excel: A step-by-step guide to spreadsheets using Microsoft Excel.

Number	Titel
41022	Scientific & Transversal Skills 2

Language	Duration	Semester	Frequency of offer	Type of module	CP
english	1 Sem.	2	Summer semester only	Compulsory	6

1	Events	Type of event	Planned group size	Workload		HPW
				Contact-hours	Self-study	
			25	60 h	120 h	4
-	Scientific and Transversal Skills 2	Lecture	60			2
-	Scientific and Transversal Skills 2	Exercise	20			2

2 Learning Outcomes / Competencies

Knowledge:
Upon completion of this module, students will be able to:
- know advanced research methods and tools of the medical informatics (scientific) domain
- know and understand business models in medical informatics
- know TOGAF and enterprise IT & business architectures
- know training concepts
- have advanced IT literacy in tools like MS Excel
- know German vocabulary and grammar at least on A2 level
- know English vocabulary and grammar at least on C2 level

Application and generation of knowledge: The students are able to
- apply research methods and tools of the scientific domain
- can develop enterprise IT architectures based on case studies
- can train users in IT tools
- use tools like MS Excel on an advanced level
- speak, understand, read and write German at least on A2 level
- speak, understand, read and write English at least on C2 level

Communication and cooperation:
- Students can cooperate in medical informatics projects
- Students can train users in digital technologies
- Students learn to communicate with people on different IT literacy levels
- Students learn to communicate in different languages, especially in German

Scientific self-understanding / professionalism:
- Students can plan and conduct scientific research in the medical informatics domain
- Students are aware of their own discipline and can interact with other discipline adequately
- Students can manage context beyond the IT technology domain

3 Course Description and Course Structure

The module is the extension of the Scientific and Transversal Skills 1 module and provides an additional set of several smaller training units to the students where they can develop specific competences. Up to 8 courses are offered in the summer term (according to availability). Students have to choose 3 out of 6 optional training units (from No. 1-6). For students without at least German A2, the German course (No. 7) is mandatory. For German native speakers, another language course has to be concluded at least on A1 level (No. 8). More courses can be added according to the analysis of the needs.

Course Structure
In the initial set up of the master a selection of 8 compact courses are offered. More can be added according to the analysis of the needs of actual students:

1. Compact course on advanced medical informatics knowledge

	2. Compact Course on TOGAF: This course conducts a 1-week intensive workshop on the TOGAF framework (The Open Group Architecture Framework). The focus is on the development of an enterprise architecture combining the business and the IT view. 3. Train-the-Trainer on IT tools for projects: The goal of the course is to let the IT students develop a training, starting from the training concept (didactics, learning objectives), then developing training materials, and finally delivering the training to students from a project management Master. 4. Research Methods and Tools – part B (RMT-B): Training on advanced scientific methods and tools in the digital transformation domain. The goal of the course is to prepare a concrete research project or a scientific publication. Students can continue the sequence of RMT-A and RMT-B plus a Research Seminar. 5. Cross-Border Project B: During the Mai Master block week or a workshop at a partner university, projects with teams of students from several partners are formed. They conduct projects, e.g. on clinical cases and present the results, e.g. in pitching. 6. ICDL-Advanced Excel: This course is preparing for the Advanced Excel certificate of the International Computer Driver License (ICDL) and the respective exams. The course puts the focus on using Excel for data analytics and business intelligence. 7. International Project Communication 2 e (German A2): A language certificate of German at least on level A1 has to be provided at the end of the semester. Respective courses are organized and embedded into the weekly schedule. 8. International Project Communication 2 g (other language): For students with native German background (e.g. German/Austrian/Swiss citizens or students with a prior degree taught in German (e.g. “Bildungsinländer”), a language certificate in an additional language (e.g. French, Spanish, Chinese, etc.) at least on A1 level is required. In case of an English language certificate, C2 level is needed.
4	**Teaching Methods** 1. Compact Course on Advanced medical informatics 2. Compact Course on TOGAF: online preparation, 1-week workshop based on case study 3. Train-the-Trainer on IT tools for projects: development of a training course (group work) 4. Research Methods and Tools – part B (RMT-B): lecture and homework (paper writing) 5. Cross-Border Project B: project and presentation 6. ICDL Advanced Excel: methods & tool training 7. International Project Communication 2 e (German A2): language training 8. International Project Communication 2 g (other language A1 or English C2): language training
5	**Participation Requirements** None
6	**Examination Forms** 1. Compact Course on Advanced medical informatics: exam 2. Compact Course on TOGAF: result presentation and review 3. Train-the-Trainer on IT tools for projects: evaluation of the training by participants 4. Research Methods and Tools – part B (RMT-B): homework (paper assignment) 5. Cross-Border Project B: presentation and discussion 6. ICDL Advanced Excel: test 7. International Project Communication 2 e (German A2): language test 8. International Project Communication 2 g (other language A1 or English C2): language test
7	**Requirements for the award of credit points** Successful completion of course Nr. 1 (graded), and 3 out of 5 technical courses (Nr. 2-6, graded), and language certificate (7 or 8). The weight for the mark of the graded courses is 1/4.
8	**Significance of the grade for the final grade** 5,00%

9	**Module Representative** Prof. Dr.-Ing. Christoph M. Friedrich **Lecturer** see current course catalog or individual study plan in the Portal of the University of Applied Sciences and Arts Dortmund
10	**Literature** See “Scientific & Transversal Skills 1” for 4-8 (1)For Advanced medical informatics training material is provided for registered students (2) specific training material is provided for registered students For TOGAF (3) online courses of instructional design are provided for registered students

Number	Titel
47614	3D Computer Vision and Augmented Reality in Medicine

Language	Duration	Semester	Frequency of offer	Type of module	CP
english	1 Sem.	1 / 2	Winter semester only	Compulsory	6

1	Events	Type of event	Planned group size	Workload		HPW
				Contact-hours	Self-study	
				60 h	120 h	4
-	Medical Computer Vision and Augmented Reality	Seminar Event	35			4

2 Learning Outcomes / Competencies

After completion of the module, students will have acquired the following competences in the field of 3D computer vision and augmented reality for medical issues:

Knowledge:
- know the importance of the fields of 3D computer vision and augmented reality for medicine and can explain them and explore them for new areas of application.
- know mathematical methods, algorithms and data structures of camera calibration, tracking of medical devices and 3D reconstruction from projections and can explain them.
- know the interoperability standards for clinical images and the helpful ontologies for tasks in the healthcare sector (e.g. FHIR, DICOM, FMA)
- know the basics and limitations of machine learning including deep learning methods for classification/segmentation/registration issues in 2D and 3D medical images.
- are familiar with the mixed reality continuum and can categorise medical applications within it.
- are familiar with modern methods of human-machine interaction that are helpful in the context of medical augmented reality issues.

Skills (abilities):
- can categorise tasks for systems for 3D reconstruction from projections and solve them independently using methods of their own choice.
- can independently develop 3D computer vision and augmented reality solutions for medical problems, either alone or in a team, using suitable programming interfaces.
- are able to select suitable features for classification/segmentation/registration and use them for a machine learning model.
- can develop experiments to objectively assess the performance of 3D computer vision and augmented reality solutions.

Competences (personal and social):
- Can argue in a goal-oriented manner in presentations and discussions and deal with criticism objectively.
- can recognise and resolve existing misunderstandings between discussion partners.
- can discuss topics related to 3D computer vision and mixed reality with clinical specialists and propose solutions.
- can present scientific results in a way that is understandable to a specialist audience.

3	**Course Description and Course Structure** - Introduction and motivation: 3D computer vision (including reconstruction from projections) and augmented reality applications in medicine - Overview of current standard software for 3D computer vision applications and introduction to selected programming interfaces, e.g. OpenCV, MevisLab libraries - Acquisition and analysis of depth images: active and passive methods - 3D interaction methods - 3D geometry, linear and affine mappings, quaternions - 3D segmentation and registration - Camera calibration: spatial and projective geometry, camera models - 3D reconstruction: stereo image analysis, epipolar geometry, correspondence analysis - Features and feature extraction: Edges and Gradients, Structure Tensor, Harris Corner Detector, Fourier Descriptors, SIFT - 3D classification, deep learning
4	**Teaching Methods** • lecture in seminar format, with blackboard and projection • solution of practice-oriented exercises, individually or in teams • Processing of programming tasks on the computer in individual or team work
5	**Participation Requirements** None
6	**Examination Forms** • oral examination • examinations taken during the course of a semester
7	**Requirements for the award of credit points** passed oral examination (80% of modules mark + 20% examinations done during the semester)
8	**Significance of the grade for the final grade**
9	**Module Representative** Prof. Dr.-Ing. Christoph M. Friedrich **Lecturer** see current course catalog or individual study plan in the Portal of the University of Applied Sciences and Arts Dortmund
10	**Literature** • Uhl, J.-F. und andere; Digital Anatomy, Springer, 2021 (elecronically available at the library) • Schmalstieg, D. und Höllerer, T.: Augmented Reality: Principles and Practice (Usability), Addison Wesley, 2016. (elecronically available at the library) • Aukstakalnis, S. Practical Augmented Reality, Addison Wesley, 2016. • Szeliski, R.; Computer Vision: Algorithms and Applications, Springer, 2010 • Hartley, R. et al.; Multiple View Geometry in Computer Vision; Cambridge University Press; 2. Auflage; 2004 • Toennis, K. D.; Guide toMedical imageAnalysis; 2te Auflage, Springer, 2017 • Preim, B. und Botha, C.; Visual Computing for Medicine , 2nd edition, Morgan Kaufman Publishers, 2014. (elecronically available at the library) • Forsyth, D. A. and Ponce, J.; Computer Vision - a modern approach, Prentince Hall, 2003 • Tönnis, M.; Augmented Reality: Einblicke in die Erweiterte Realität; Springer; 2010

- Furht, B. et al.; Handbook of Augmented Reality; Springer; 2011

Number	Titel
47612	Advanced Methods in Biomedical Signal and Image Processing

Language	Duration	Semester	Frequency of offer	Type of module	CP
german	1 Sem.	1 / 2	Winter semester only	Compulsory	6

1	Events	Type of event	Planned group size	Workload		HPW
				Contact-hours	Self-study	
				60 h	120 h	4
-	Advanced Medical Image and Signal Processing	Seminar Event	35			4

2 Learning Outcomes / Competencies

Knowledge and Understanding:

Upon successful completion of the course, students will be able to:

- explain, select and apply the essential steps of bio-signal analysis using the example of the detection of QRS complexes in ECG signals
- explain and compute advanced mathematical models and methods of signal and image transformation, as well as describe their formal foundations
- describe and differentiate machine learning methods, particularly deep learning, for analyzing biosignals and medical images

Deployment, Application, and Generation of Knowledge:

Upon successful completion of the module, students will be able to:

- review scientific literature using the example of QRS detection in ECG signals and to understand the methods on their own
- independently analyze biosignals and medical images and adapt the methods covered to new tasks
- implement and test signal and image transformation methods using the software ecosystem of Python, Matplotlib, NumPy, SciPy and to apply these methods to practical problems
- Evaluate the accuracy of these methods through large datasets of ECG signals from a public database (PhysioNet) and discuss the results
- Implement machine learning and deep learning methods and models using SciPy and PyTorch and optimize their training

Communication and Cooperation:

Upon successful completion of the module, students will be able to:

- address and solve programming tasks at a computer in small teams
- experiment task oriented in small groups, for example, to optimize a deep learning model
- critically reflect upon their own approaches, defend them if necessary, and critique alternative solutions

Scientific Self-Image / Professionalism:

Upon successful completion of the module, students will be able to:

- pursue an evidence- and research-based approach in developing software solutions
- resolve technical problems typical of their professional field, such as the analysis of biosignals and medical images

	• abstract from concrete problem scenarios specific to their professional field and recognize fundamental solution approaches • justify the use of their chosen methods to experts in the field • assess the importance of interdisciplinary collaboration with professionals from medicine, computer science, and other disciplines
3	**Course Description and Course Structure** • Biosignal Processing: Signal analysis in Electrocardiography (ECG), Electroencephalography (EEG), and Electrooculography (EOG) • Important signal and image transformations and their applications in Medical Technology: Fourier Transform, Short-time Fourier Transform, Wavelet Transform, Hilbert Transform, Discrete Cosine Transform • Sampling Theorem, Signal Filtering, Polynomial Curve Fitting, Mathematical Morphology • Multi-resolution Analysis, Multi-scale Parameter Estimation • Image Compression Methods: Huffman, Arithmetic, LZW, Bit-plane Coding; JPEG Compression
4	**Teaching Methods** • Lecture in a seminar-style format, interacting with students, using blackboard writing and projections • Exercises closely integrated with the lecture content, interacting with students, using blackboard writing and projections. Explanation of the task and joint development and outlining of a solution approach • Practical lab sessions closely integrated with the lecture content; working on programming tasks on the computer individually or in teams
5	**Participation Requirements** None
6	**Examination Forms** The course exam consists of a written test in which the students are expected to recall and apply fundamental knowledge of advanced methods in signal and image processing. Furthermore, they should be able to transfer and, if necessary, apply this knowledge to practical problems. This includes, among other things, creating short scripts in Python or completing given scripts. Duration: 90 minutes.
7	**Requirements for the award of credit points** The written exam will be graded and must be completed with at least a sufficient (4.0) score.
8	**Significance of the grade for the final grade**
9	**Module Representative** Prof. Dr. Markus Kukuk **Lecturer** see current course catalog or individual study plan in the Portal of the University of Applied Sciences and Arts Dortmund
10	**Literature** • Selesnick, I. et al.; Signal Processing in Medicine and Biology - Emerging Trends in Research and Applications; Springer; 2020 • Handels, H.; Medizinische Bildverarbeitung; Vieweg+Teubner; 2. Edition; 2009 • Birkfellner W.; Applied Medical Image Processing; Taylor & Francis; 2010 • Nischwitz, A. et al.; Computergrafik und Bildverarbeitung: Band II: Bildverarbeitung; Vieweg+Teubner; 4. Edition, 2020 • Bankman, I. et al.; Handbook of Medical Image Processing and Analysis; Academic Press; 2. Edition; 2009 • Lyons, R.; Understanding Digital Signal Processing; Prentice Hall; 3. Edition; 2010 • Sonka, M. et al.; Image Processing, Analysis, and Machine Vision; Thomson; 3. Edition; 2008

Number	Titel
47613	Knowledge based systems in medicine

Language	Duration	Semester	Frequency of offer	Type of module	CP
english	1 Sem.	1 / 2	Summer semester only	Compulsory	6

1	Events	Type of event	Planned group size	Workload		HPW
				Contact-hours	Self-study	
				60 h	120 h	4
-	Knowledge-Based Methods and Systems in Medicine	Seminar Event	35			4

2 Learning Outcomes / Competencies

Professional and methodological competence:
After completing the module, students will be able to name the different types of knowledge as well as their special features and differences. They will be familiar with various organizational structures for knowledge storage and will be able to evaluate their suitability for given scenarios. They will be able to gain an overview of the different types of knowledge-based methods and systems and independently develop solution and system concepts for given practical application scenarios.
Among other things, students are able to

- name and explain the types of knowledge and their use in medicine
- describe the structure and functioning of knowledge-based systems in general and specifically in medicine
- model the knowledge of different types of knowledge
- select technologies and organizational structures for computer-based knowledge storage and processing
- create concepts for the implementation of knowledge bases as well as knowledge-based and decision-supporting informatics artifacts and systems in medicine and critically evaluate their suitability

Social competence:

- Cooperation in analyzing and researching new topics
- Discussions on specific aspects of the course

Occupational field orientation:

- Implementation competence for smaller artifacts of knowledge-based decision support in medicine

3 Course Description and Course Structure

- Basic structure of knowledge-based and decision-support systems
- Knowledge base
- Authoring system for knowledge engineer
- Inference engine
- Control module
- Fact database
- User interface
- Interfaces to operational information systems
- Basic structures for knowledge storage
- Medical information portals

	• Fact data and action repositories • Case collections and descriptions • Ontologies • Medical guidelines, clinical pathways and algorithms • Decision tables and matrices • Rule-based systems • Aspects of the context-sensitive coupling of information systems and knowledge applications • Semantic aspects • EAV-based coupling • Mechanisms of system-internal triggering • Machine Learning (ML) based approaches to decision support • - Basic functionality of ML • - Possible applications in medicine: opportunities and risks • - Evaluation of their reliability and explainability (explainable artificial intelligence, xAI) • Selected applications and their implementation specifics as well as persistence structures in medicine • CPOE • AMTS applications • Applications to improve patient safety • Guideline application • Application of clinical pathways and algorithms • Laboratory diagnostics • Decision-support systems in differential diagnostics • Decision-support approaches in image processing
4	**Teaching Methods** • Lecture in interaction with the students, with blackboard writing and projection • Lecture-accompanying processing of project tasks in teamwork with presentation • Active, self-directed learning through the use of electronic learning materials • Excursion
5	**Participation Requirements** None
6	**Examination Forms** • Examinations during term with presentation
7	**Requirements for the award of credit points** • Passed examinations during term with presentation
8	**Significance of the grade for the final grade**
9	**Module Representative** Prof. Dr. Darius Schippritt **Lecturer** see current course catalog or individual study plan in the Portal of the University of Applied Sciences and Arts Dortmund

10 Literature

- Acharjya, D. P., & Ma, K. (Eds.). (2024). *Computational Intelligence in Healthcare Informatics*. Springer.
- Berner, E. S. (2007). *Clinical decision support systems* (Vol. 233). New York: Springer Science+ Business Media, LLC.
- Hunink, M. M., Weinstein, M. C., Wittenberg, E., Drummond, M. F., Pliskin, J. S., Wong, J. B., & Glasziou, P. P. (2014). *Decision making in health and medicine: integrating evidence and values*. Cambridge university press.
- Penman, I. D., Ralston, S. H., Strachan, M. W., & Hobson, R. (Eds.). (2022). *Davidson's Principles and Practice of Medicine E-Book: Davidson's Principles and Practice of Medicine E-Book*. Elsevier Health Sciences.
- Sackett, D. L. (1997, February). Evidence-based medicine. In *Seminars in perinatology* (Vol. 21, No. 1, pp. 3-5). WB Saunders.
- Simon, G. J., & Aliferis, C. (2024). Artificial intelligence and machine learning in health care and medical sciences: best practices and pitfalls.
- Topol, E. (2019). *Deep medicine: how artificial intelligence can make healthcare human again*. Hachette UK.
- Warner R., Sorensen D. K., Bouhaddou O.: Knowledge Engineering in Health Informatics. Springer New York 1997.

Number	Titel
47401	Advanced Telemedicine Applications and Technologies

Language	Duration	Semester	Frequency of offer	Type of module	CP
english	1 Sem.	1 / 2	Summer semester only	Compulsory	6

1	Events	Type of event	Planned group size	Workload		HPW
				Contact-hours	Self-study	
				60 h	120 h	4
-	Methods and Tools / Applications in Telemedicine	Seminar Event	35			4

2 Learning Outcomes / Competencies

Knowledge and Understanding

Students:

- Have an in-depth understanding of telemedicine projects and can analyze, classify, and describe them using a systematic methodology.
- Are familiar with the legal and regulatory framework in the field of data protection, particularly in relation to telemedicine applications.
- Understand the concepts and requirements of the electronic case record (eFA) and the electronic patient record (eEPA) and can assess their suitability for various application scenarios.
- Can differentiate between telemedicine, teletherapy, and telemonitoring and classify new issues into existing concepts accordingly.
- Are familiar with the basics of digital health applications (DiGA) and their significance for medical care.
- Understand the requirements of the telematics infrastructure (TI) and its impact on the implementation and use of telemedicine applications.
- Have knowledge of medical vital parameter sensors and their application in telemedicine.
- Are aware of the regulatory requirements for medical devices and their approval in the telemedicine context.

Application, Use, and Generation of Knowledge

Students are able to:

- Analyze and evaluate telemedicine projects considering technical, organizational, and legal aspects.
- Systematically take data protection requirements into account when planning and implementing telemedicine solutions.
- Integrate communication solutions such as eFA and eEPA into specific application contexts and make informed decisions regarding their suitability for various scenarios.
- Identify new developments in telemedicine, teletherapy, and telemonitoring and derive their potential benefits for different application cases.
- Understand the financing options for telemedicine applications and assess their economic viability.
- Apply evaluation methods to scientifically verify the effectiveness and evidence of telemedicine solutions.
- Utilize medical vital parameter sensors for monitoring and diagnostics in telemedicine applications.
- Assess medical devices in telemedicine scenarios concerning regulatory requirements and technical specifications.

Communication and Cooperation

Students:

- Work effectively in interdisciplinary teams and organize themselves within project groups.
- Conduct qualified interviews with experts and users to identify the requirements and challenges of telemedicine solutions.
- Present their analyses and solution approaches professionally and target-group-oriented.

	• Reflect on and discuss telemedicine developments and their impact in interdisciplinary expert discussions. **Scientific Self-Understanding / Professionalism** Students: • Have a deep understanding of market-relevant telemedicine applications and can evaluate them in the context of healthcare provision. • Recognize technological trends and regulatory developments in telemedicine and can critically assess them. • Reflect on the social, ethical, and economic implications of telemedicine solutions. • Are capable of continuously working on new topics in telemedicine and further developing their expertise through scientific methods. • Understand the importance of evidence-based approaches in telemedicine and can apply evaluation criteria for digital health applications and telemedicine concepts. • Are familiar with the regulatory requirements for medical devices and can incorporate them into the design and development of telemedicine applications.
3	**Course Description and Course Structure** • Definitions of telecooperation, telemonitoring, and teletherapy with examples • Introduction of a systematic approach for telemedicine projects (from healthcare challenges to solution approaches, cooperation structures, cost-benefit analysis, and business models) • Data protection in the field of telemedicine and telematics • Communication solutions in healthcare and their relation to telemedicine • DiGA (Digital Health Applications) • Health telematics • Sensor technology and vital parameters • Regulations for medical devices • Financing in the German healthcare system • Evidence of telemedicine solutions • Application of these contents to an individual case study, which is developed throughout the semester and presented at the end
4	**Teaching Methods** • lecture in seminar format, with blackboard and projection • lectures with flipchart, SmartBoard or projection • lecture accompanying project work with final presentation
5	**Participation Requirements** None
6	**Examination Forms** • Project work with a final presentation of results
7	**Requirements for the award of credit points** • Successfully completed project work with a final presentation
8	**Significance of the grade for the final grade**

9	**Module Representative** Prof. Dr. Thomas Königsmann **Lecturer** see current course catalog or individual study plan in the Portal of the University of Applied Sciences and Arts Dortmund
10	**Literature** • Tagungsbände Telemed • Tagungsunterlagen DGTelemed • Bartmann et al; Telemedizinische Methoden in der Patientenversorgung; Deutscher Ärzteverlag 2012

Number	Titel
47402	Epidemiology and Applications in Healthcare

Language	Duration	Semester	Frequency of offer	Type of module	CP
english	1 Sem.	1 / 2	Winter semester only	Compulsory	6

1	Events	Type of event	Planned group size	Workload		HPW
				Contact-hours	Self-study	
				60 h	120 h	4
-	Epidemiology and Medical Informatics Applications in Healthcare	Seminar Event	35			4

2 Learning Outcomes / Competencies

The course deals with the theoretical/scientific fundamentals of epidemiology and their practical application. After successfully completing the course, students will have acquired the following competences:

Knowledge:
- know the most important basic technical terms from the fundamentals of epidemiology and health services research and can name them
- know the difference between primary data collection and secondary data
- know epidemiological measures such as morbidity measures, mortality measures, absolute risk, risk difference, relative risk, odds ratio and can name them
- know the most important epidemiological study types and know the typical areas of application
- know the most important sources of bias, bias and confounding and can describe them formally and use them to assess the limitations of epidemiological publications

Skills
- can calculate epidemiological measures independently
- can determine suitable study types and select them for their own applications
- can design questions for epidemiological and health services research studies
- can select suitable methods to avoid bias
- can question and discuss the conduct and presentation of results of epidemiological studies (in publications)
- can plan epidemiological mini-projects independently in a team, carry out, analyse and document

Competences (personal and social skills)
- can formulate ideas and proposed solutions orally and in writing
- can solve tasks in exercises and projects independently and present the results
- can independently develop and present theoretical content from scientific literature
- can develop solutions cooperatively in the exercise and project phases
- can cooperatively plan, distribute and jointly carry out tasks for solutions in the project phases
- can argue in discussions in a goal-oriented manner and deal with criticism objectively
- can present the results of group work together
- can evaluate project results and formulate suggestions for improvement

3 Course Description and Course Structure

- Types of studies (descriptive studies, analytical studies, randomised controlled trials, observational studies, cross-sectional or prevalence studies, cohort studies, case-control studies)
Areas of application, advantages and disadvantages of study types
Sources of bias, Bias and confounding

- Statistical methods of epidemiology
Methods and techniques of data presentation
Descriptive statistics and basics of correlation analysis

	- Fields of application of epidemiology Cardiovascular epidemiology, cancer epidemiology, occupational epidemiology, health policy - Research and methodology: Formulating epidemiologically testable research questions and hypotheses Developing study designs in line with the research question Methods and concepts of gaining knowledge from routine health care data Data management and data analysis in the context of epidemiological research / health services research - Forms of presentation (poster, lecture, podcast, etc.).)
4	**Teaching Methods** • lecture in seminar format • solution of practice-oriented exercises, individually or in teams
5	**Participation Requirements** None
6	**Examination Forms** paper and presentation
7	**Requirements for the award of credit points** succesful seminar presentation and paper
8	**Significance of the grade for the final grade**
9	**Module Representative** Prof. Dr.-Ing. Christoph M. Friedrich Claudia Dr.rer.medic. Pieper **Lecturer** see current course catalog or individual study plan in the Portal of the University of Applied Sciences and Arts Dortmund
10	**Literature** Kreienbrock, L, Schach S: Epidemiologische Methoden. Spektrum Akademischer Verlag GmbH, Heidelberg, Berlin Will be announced during the course

Number	Titel
47403	Applied Artificial Intelligence in Medicine

Language	Duration	Semester	Frequency of offer	Type of module	CP
english	1 Sem.	1 / 2	Summer semester only	Compulsory	6

1	Events	Type of event	Planned group size	Workload		HPW
				Contact-hours	Self-study	
				60 h	120 h	4
-	Applied Artificial Intelligence in Medicine	Seminar Event	35			4

2 Learning Outcomes / Competencies

The course deals with the basics and applications of artificial intelligence (AI) in medicine. After successfully completing the course, students will have acquired the following competences:

Knowledge:
- know the most important technical terms of AI in medicine and can use them to explain systems.
- are familiar with the Smart Hospital Information Platform (SHIP) and can explain its individual elements
- are familiar with interoperability standards such as FHIR, DICOM and others
- are familiar with regulatory principles in medical informatics

Skills
- can question and discuss ethical principles and limits of AI methods in medicine
- can select suitable AI methods for applications in medicine
- can implement simple AI solutions with JupyterHub
- can plan, implement, analyse and document mini-projects related to AI in medicine independently in a team.

Competences (personal and social skills)
- can formulate ideas and proposed solutions orally and in writing
- can solve tasks in exercises and practicals independently and present the results
- can independently develop and present theoretical content on the topic of machine learning from scientific literature
- can develop solutions cooperatively in the exercise and project phases
- can plan tasks for solutions cooperatively in the project phases, and carry them out together
- can argue in discussions in a goal-oriented manner and deal with criticism objectively
- can present the results of group work together
- can evaluate project results and formulate suggestions for improvement
- can recognise and reduce misunderstandings between discussion partners

3 Course Description and Course Structure

- Basics of medical data formats (FHIR, DICOM, time series, text data) and their processing
- Introduction to computer vision for medical image analysis
- Basic concepts of artificial intelligence (AI) in medicine
- Methods of artificial intelligence (AI) in medicine
- Knowledge graphs as possible solutions for medicine
- Design of evaluation studies for AI projects and implementation of such studies
- Basics of survival analysis for predictive modelling
- Use of large language models (LLMs) for medical applications
- Implementation of AI models with Python and relevant libraries (PyTorch, scikit-learn, pandas, numpy, lifelines)
- Problem solving using the example of study programme-related mini-projects for medical applications (student mini-projects in teams of 2-3)

The topics are to be developed in depth using current research topics, including, among others
- Development of an algorithm for recognising body regions on CT topograms using YOLOv11

	- Classification of sepsis patients using hyperspectral imaging with RandomForest - Development of a patient-centred retrieval augmented generation (RAG) system for interaction with patient records - Storage and integration of AI results in FHIR resources for interoperable use
4	**Teaching Methods** lecture in seminar format programming tasks on the computer in individual or team work Project work accompanying the lecture with final presentation
5	**Participation Requirements** None
6	**Examination Forms** Written examination paper or oral examination (according to the current examination schedule) - 70% of necessary examination performance Semester-long coursework (30% of necessary examination performance)
7	**Requirements for the award of credit points** • passed written examination or oral exam • succesful seminar presentation
8	**Significance of the grade for the final grade**
9	**Module Representative** Prof. Dr.-Ing. Christoph M. Friedrich **Lecturer** see current course catalog or individual study plan in the Portal of the University of Applied Sciences and Arts Dortmund
10	**Literature** will be announced in the course, materials will be provided

Number	Titel				
47652	Research Project				
Language	**Duration**	**Semester**	**Frequency of offer**	**Type of module**	**CP**
english	1 Sem.	3	each semester	Compulsory	12

1	Events	Type of event	Planned group size	Workload		HPW
				Contact-hours	Self-study 360 h	

2 Learning Outcomes / Competencies

Knowledge
- Knows state of the art in a certain scientific field
- Knows open research questions in this field
- Knows relevant literature
- Knows methodology and tools to execute project

Skills
- Can define and plan an own research project
- Can apply appropriate research methodology
- Can create own research findings
- Can describe project execution, methodology and findings in a scientific report
- Can write a research thesis about the chosen topic

Competence – attitude
- Can run an own more complex scientific research project
- Masters uncertainty and unknown topics in new area
- Can present and defend results (in colloquium or at a conference)

3 Course Description and Course Structure

The research project is intended to introduce students into scientific research work in a bigger context. Students will participate in one of the ongoing research projects. They will contribute with an own sub project. The starting point is the definition of the research questions they want to answer and the selection of the appropriate methodology. The students will plan and execute their project independently with regular review and consulting. They will summarize their finding in a research project thesis (project report). The research project will be a preparation for further work on the master thesis. The intention of the research project is to familiarize with the research methodology in a certain scientific field and to formulate the scientific state of the art and the research questions. The student proves the ability to execute own and independent research on master level and with a certain complexity.

Course Structure

Students will select a topic from one of the ongoing projects or a topic from medical informatics at the University hospital Essen. They will get individual consulting and feedback. During the semester the students will write a project thesis and present it in a colloquium at the end of the semester.

Excellent results are intended to be published and presented (oral or poster) at a conference (can be done in connection with the master thesis, too).

Application Focus

	The Research Project (Thesis) is done in connection with a medical informatics research project. It is recommended to do the project and the thesis in connection with an internship/student job in the medical informatics industry or within a research project at university or research institute.
4	**Teaching Methods** Project Theses are done with individual supervision: - Project Work, in a scientific project or within an internship in industry - Writing of a scientific report - Presentations to communicate and discuss the findings - Individual review and feedback on papers and presentations
5	**Participation Requirements** None
6	**Examination Forms** written research thesis Colloquium
7	**Requirements for the award of credit points** graded research thesis (80% of mark) and passed colloquium (20% of mark)
8	**Significance of the grade for the final grade**
9	**Module Representative** Prof. Dr.-Ing. Christoph M. Friedrich **Lecturer** see current course catalog or individual study plan in the Portal of the University of Applied Sciences and Arts Dortmund
10	**Literature** According to topic

Number	Titel
47641	MI Teamproject

Language	Duration	Semester	Frequency of offer	Type of module	CP
english	1 Sem.	3	each semester	Compulsory	6

1	Events	Type of event	Planned group size	Workload		HPW
				Contact-hours	Self-study	
				30 h	150 h	2
-	MI Teamproject	Seminar	15			2

2 Learning Outcomes / Competencies

The course is a team project with 5-12 participants in which a scientific project in medical informatics is planned and developed together. Project mentors from medical informatics companies or practice partners from hospitals (e.g. Essen University Hospital) are involved to provide support. After successful participation in the course, students will have acquired the following competences:

Knowledge:
- know the methods of qualified literature research
- know methods for selecting software frameworks
- know the current state of research of the selected project

Skills
- can formulate and present intermediate and final results in an understandable way
- can apply methods of medical software and hardware development in a scientific context
- can work scientifically in a team on a given topic from the context of current research in medical informatics
- can design experiments to demonstrate the performance of the project solution
- can categorise and present the state of the art for their chosen topic and find their own approaches for further development.

Competences (personal and social skills)
- can master the organisation and development of a scientific project together (students organise the distribution of tasks and review independently)
- can formulate ideas and proposed solutions orally and in writing
- can co-operatively plan, distribute and jointly carry out tasks for solutions in the project phases
- can argue in a goal-oriented manner in discussions and deal with criticism objectively
- can present the results of group work together
- can evaluate project results and formulate suggestions for improvement
- can recognise and resolve misunderstandings between discussion partners

3 Course Description and Course Structure

On the basis of a short introductory presentation of the application or the application area of the project, tasks are assigned for independent work by the team, which are to be carried out in accordance with good scientific practice and should also include a more complex software implementation. Ideally, the result will lead to a joint scientific publication.

4 Teaching Methods

- Group work
- Project work
- independent scientific work

5 Participation Requirements

None

6	**Examination Forms** • Project presentation and hand in of documentation and software artefacts
7	**Requirements for the award of credit points** • succesful presentation and hand in of software artefacts and documentation. Individual mark based on equally weighted criteria: Teamwork, Software, Mangagement, documentation and presentation
8	**Significance of the grade for the final grade**
9	**Module Representative** Prof. Dr.-Ing. Christoph M. Friedrich **Lecturer** see current course catalog or individual study plan in the Portal of the University of Applied Sciences and Arts Dortmund
10	**Literature** Literature must be identified by the students themselves in relation to the chosen topic.

Number	Titel
48202	Human Centered Digitalization

Language	Duration	Semester	Frequency of offer	Type of module	CP
english	1 Sem.	3	Winter semester only	Core elective	6

1	Events	Type of event	Planned group size	Workload		HPW
				Contact-hours	Self-study	
			25	60 h	120 h	4
-	Human Centered Digitalization	Seminar Event				4

2 Learning Outcomes / Competencies

Learning outcomes

Knowledge
- Knows relevant theoretical foundations, area: computer science and society
- Know methodical background of case studies and surveys
- Is aware of critical limitations of methods for evaluating impact

Skills
- Can analyze the impact of changes in information technology on individuals, environment and society, based upon a given past scenario
- Can evaluate, analyze (and within limits predict) the impact of new products/services on individuals, environment and society, during the concept and development phase
- Can conduct methodologically structured evaluations (e.g. field observation, lab tests) and surveys

Competence – attitude
- Can discuss impacts of changes in information technology on individuals, environment and society with experts
- Can advise during product/service development potential impacts of product/service structure/features on individuals, environment and society
- Understands scientific publication in the related areas

3 Course Description and Course Structure

Course Description

Digitalization in private and professional domains is influencing intensely and sometimes even revolutionizing people's life, the way they interact with systems, the way they interact between each other, the way a society changes. Within this course those influences will be addressed from two different viewpoints. From an analytical perspective, former and current developments and their influences will be analyzed and then projected on future trends. From a constructive perspective, those potential influences of e.g. a product or service currently in development will be taken into account to shape the prospective solution.

Course Structure
- Basic Overview "Computer Science & Society"
- Ethics in computer science
- Digital media and art
- Surveillance and privacy
- Artificial Intelligence and responsibility
- Case Studies "Disruptive Changes by Information Technology"
- Digitalization of work life & work environments, processes, products and services
- Evaluation of impacts (personal, environment, society)

Application Focus

	Case Studies “Disruptive Changes by Information Technology” Involvement in projects: Analyzing impacts and potentials for news products and services **Scientific Focus** (Pre-)Studies & surveys about socioeconomic impacts of digitalization Paper with literature review/state-of-the-art Skills trained in this course: theoretical knowledge, practical skills and scientific competences
4	**Teaching Methods** **Teaching and training methods** • Theoretical knowledge: e-learning modules on formal methods, tool tutorials • Practical Skills: Projects with MechatronicUML • Scientific Competences: literature review and synthesis into a paper
5	**Participation Requirements** None
6	**Examination Forms** Assessment of the course: Practical Skills (50%): Group work and/or individual task, case studies and projects => demonstration/presentation of the result an Scientific Competences (50%): written paper (literature review, study report or survey, approx. 25 pages) and presentation (in class or at a student conference, e.g. International Research Conference Dortmund)
7	**Requirements for the award of credit points** Passed exam and passed semester assignments
8	**Significance of the grade for the final grade** 5,00%
9	**Module Representative** Prof. Dr. Christian Reimann **Lecturer** see current course catalog or individual study plan in the Portal of the University of Applied Sciences and Arts Dortmund
10	**Literature** **References** Changing conference proceedings and journals, e.g. ICT and Society: 11th IFIP TC 9 International Conference on Human Choice and Computers, HCC11 2014, Turku, Finland, July 30 - August 1, 2014, Proceedings 431 IFIP Advances in Information and Communication Technology, Springer, 2014, ISBN 3662442086, 9783662442081 eHealth: Legal, Ethical and Governance Challenges, Carlisle George, Diane Whitehouse, Penny Duquenoy, Springer Science & Business Media, 2012, ISBN 3642224741, 9783642224744 An Ethical Global Information Society: Culture and democracy revisited IFIP Advances in Information and Communication Technology, Jacques J. Berleur, Diane Whitehouse, Springer, 2013, ISBN 0387353275, 9780387353272

	Human Choice and Computers: Issues of Choice and Quality of Life in the Information Society Band 98 von IFIP Advances in Information and Communication Technology, Klaus Brunnstein, Jacques Berleur, Springer, 2013, ISBN 0387356096, 9780387356099

Number	Titel
46854	Advanced Web Engineering

Language	Duration	Semester	Frequency of offer	Type of module	CP
english	1 Sem.	1 / 2	Winter semester only	Core elective	6

1	Events	Type of event	Planned group size	Workload		HPW
				Contact-hours 60 h	Self-study 120 h	4
-	Advanced Web Engineering	Lecture	60			2
-	Advanced Web Engineering	Internship	15			2

2 Learning Outcomes / Competencies

Knowledge and understanding: Upon completion of this module, students will have deepened and intensified their abilities to

- analyze and differentiate between different web architectures and central architectural patterns of web applications,
- name and categorize important web standards and technologies.

Use, application and generation of knowledge: Upon completion of this module, students will be able to

- implement a complex web engineering task within the context of a project over several weeks,
- derive and design a suitable web architecture for solving a specific problem,
- determine and combine suitable web standards and technologies for implementing this architecture,
- use advanced web engineering tools, such as development environments, bundlers, scaffolding and transpilers.

Communication and cooperation: Upon completion of this module, students will be able to

- develop and implement solutions cooperatively in a team,
- present, explain and discuss their ideas and solutions using different formats such as group presentations, code reviews, lightning talks or pitches, particularly in front of an expert audience (e.g. guests/partners from the industry or from research projects).

Scientific self-image / professionalism: Upon completion of this module, students will be able to

- select and apply industrial and scientific best practices from web engineering,
- reflect and evaluate feedback, e.g. gathered from code reviews with experts, and to autonomously implement the feedback they receive to improve their solutions.

3 Course Description and Course Structure

Course Description:
In this module, students gain an overview of the architectures of complex web applications and analyze their differences and areas of application. They learn how corresponding web applications can be implemented by selecting and using suitable client and server-side technologies.

Course Structure:
The module covers the following topics:

1. Brief review of the basics of building websites with HTML, CSS and JavaScript (Bachelor material)
2. Identification, analysis and differentiation of architectures of modern web applications:
    1. Architectural patterns such as MVC and its variants (MVVM, MVP, etc.)
    2. Request-based and component-based backend web frameworks
    3. Single vs. multi page applications, server-side rendering, client-side rendering, hybrid approaches (e.g. rehydration, resumability)
    4. Reactive programming/streaming

	3. In-depth study of server-side technologies for the development of web applications (e.g. with Java, JavaScript) 4. In-depth study of client-side concepts and technologies for the development of web applications (e.g. component-based development, state management, routing) 5. Overview of current developments in web standards and research (e.g. Web Components, WebAssembly)

4	**Teaching Methods**
	• Flipped/inverted classroom:
	  • Online E-Learning materials with interactive slides and videos (asynchronous self-study)
	  • Interactive classroom sessions (on-premise) for tasks and exercises based on examples from practice and research (e.g. coding, group exercises, lightning talks), for additional in-depth content, and for answering and discussing questions
	• Lab project: Project task which is worked on in teams over the entire semester
	• Guest lectures featuring experts and recent topics from research and industry

5	**Participation Requirements** None
6	**Examination Forms** Written exam (60%, 60-90 minutes) or oral exam (60%, 20-25 minutes); lab project (project-based work, 40%)
7	**Requirements for the award of credit points** Passed written or oral exam (according to current exam schedule); passed lab project
8	**Significance of the grade for the final grade**
9	**Module Representative** Prof. Dr. Sven Jörges **Lecturer** see current course catalog or individual study plan in the Portal of the University of Applied Sciences and Arts Dortmund
10	**Literature** • Simpson, Kyle (2015-2020): You Don't Know JS (Yet), Volume 1-6, O'Reilly/Independently published • Ullenboom, Christian (2024): Spring Boot and Spring Framework 6, Rheinwerk Computing • Jacobson, Daniel; Brail, Greg; Woods, Dan (2011): APIs: A Strategy Guide: Creating Channels with Application Programming Interfaces, O'Reilly • Masse, Mark (2011): REST API Design Rulebook: Designing Consistent Restful Web Service Interfaces, O'Reilly • Porcello, Eve; Banks, Alex (2018): Learning GraphQL: Declarative Data Fetching for Modern Web Apps, O'Reilly • Bass, Len; Clements, Paul; Kazman, Rick (2021): Software Architecture in Practice, SEI Series in Software Engineering, Fourth Edition, Addison-Wesley Professional • Osmani, Addy (2023): Learning JavaScript Design Patterns: A JavaScript and React Developer's Guide, Second Edition, O'Reilly *Relevant standards:* • Ecma International (2025): ECMA-262: ECMAScript® 2025 language specification, 16th Edition, https://tc39.es/ecma262/ • WHATWG (2025): HTML Living Standard, https://html.spec.whatwg.org/ • WHATWG (2025): DOM Living Standard, https://dom.spec.whatwg.org • WHATWG (2025): Fetch Living Standard, https://fetch.spec.whatwg.org • GraphQL Foundation (2025): GraphQL Specification, http://spec.graphql.org

Number	Titel
46862	Design and Modeling of Complex Software Architectures

Language	Duration	Semester	Frequency of offer	Type of module	CP
english	1 Sem.	1 / 2	Summer semester only	Core elective	6

1	Events	Type of event	Planned group size	Workload Contact-hours 60 h	Workload Self-study 120 h	HPW 4
-	Design and Modeling of Complex Software Architectures	Internship	15			2
-	Design and Modeling of Complex Software Architectures	Lecture	60			2

2 Learning Outcomes / Competencies

Knowledge and understanding: Upon completion of this module, students will be able to

- differentiate basic principles of software design,
- differentiate and categorize relevant tools and methods for domain-driven design,
- name and classify current research approaches to modeling software architectures.

Use, application and generation of knowledge: Upon completion of this module, students will be able to

- analyze a complex domain and break it down into subdomains,
- implement a complex software design task within the context of a project over several weeks,
- select and apply adequate principles of software design to concrete application scenarios,
- differentiate, analyze, and apply key patterns at the macro- and micro-architecture level,
- select, combine and implement suitable methods for domain-driven design.

Communication and cooperation: Upon completion of this module, students will be able to

- develop and implement solutions cooperatively in a team,
- select and apply appropriate methods for the interdisciplinary development of solutions, in particular together with domain experts without technical background,
- present, explain and discuss their ideas and solutions using different formats such as group presentations, code reviews, lightning talks or pitches, particularly in front of an expert audience (e.g. guests/partners from the industry or from research projects).

Scientific self-image / professionalism: Upon completion of this module, students will be able to

- select and apply industrial and scientific best practices for software design,
- reflect and evaluate feedback, particulary from non-technical domain experts, and to autonomously implement the feedback they receive to improve their solution designs.

3 Course Description and Course Structure

Course Description:
In this module, students deepen their competencies in designing software architectures of complex systems. Students learn how to design a scalable, robust and maintainable software architecture in a domain-driven manner by selecting and applying suitable principles, patterns and methods. The analysis and discussion of such software architectures is based on practical examples and concrete solutions from research projects.

Course Structure:
The module covers the following topics:

	1. Short repetition of the Bachelor material on software design (e.g. design patterns according to Gamma et al., Separation of Concerns, layered architecture) 2. In-depth aspects of software design: 1. Principles (e.g. loose coupling - high cohesion, SOLID) 2. Architecture patterns (e.g. ports and adapters, CQRS) 3. Methods (e.g. Domain-Driven Design, T&M approach) 3. Characteristics and patterns of modern architectural styles (e.g. modular architectures, event-based architectures, microservice architectures) 4. Model-driven design, development and reconstruction of software architectures
4	**Teaching Methods** • Flipped/inverted classroom: • Online E-Learning materials with interactive slides and videos (asynchronous self-study) • Interactive classroom sessions (on-premise) for tasks and exercises based on examples from practice and research (e.g. coding, group exercises, lightning talks), for additional in-depth content, and for answering and discussing questions • Lab project: Project task which is worked on in teams over the entire semester • Guest lectures featuring experts and recent topics from research and industry
5	**Participation Requirements** None
6	**Examination Forms** Written exam (60%, 60-90 minutes) or oral exam (60%, 20-25 minutes); lab project (project-based work, 40%)
7	**Requirements for the award of credit points** Passed written or oral exam (according to current exam schedule); passed lab project
8	**Significance of the grade for the final grade**
9	**Module Representative** Prof. Dr. Sven Jörges **Lecturer** see current course catalog or individual study plan in the Portal of the University of Applied Sciences and Arts Dortmund
10	**Literature** • Vernon, Vernon (2016): Domain-Driven Design Distilled, Addison-Wesley • Evans, Eric (2003): Domain-Driven Design: Tackling Complexity in the Heart of Software, Addison-Wesley • Richardson, Chris (2018): Microservice Patterns: With examples in Java, Manning • Martin, Robert C. (2017): Clean Architecture: A Craftsman's Guide to Software Structure and Design, Pearson • Lilienthal, Carola (2019): Sustainable Software Architecture: Analyze and Reduce Technical Debt; dpunkt.verlag • Bass, Len; Clements, Paul; Kazman, Rick (2021): Software Architecture in Practice, SEI Series in Software Engineering, Fourth Edition, Addison-Wesley Professional • Gamma, Erich; Helm, Richard; Johnson, Ralph; Vlissides, John (1994): Design Patterns: Elements of Reusable Object-Oriented Software, Addison-Wesley • Combemale, Benoit; France, Robert; Jézéquel, Jean-Marc; Rumpe, Bernhard; Steel, James; Vojtisek, Didier (2016): Engineering Modeling Languages. CRC Press • Rademacher, Florian (2022). A language ecosystem for modeling microservice architecture, Phd Thesis, https://dx.doi.org/doi:10.17170/kobra-202209306919

Number	Titel
46857	Selected Aspects of Information Security

Language	Duration	Semester	Frequency of offer	Type of module	CP
english	1 Sem.	1 / 2	Winter semester only	Core elective	6

1	Events	Type of event	Planned group size	Workload		HPW
				Contact-hours 60 h	Self-study 90 h	4
-	Specific Topics of Information Security	Lecture	60			2
-	Specific Topics of Information Security	Internship	20			2

2 Learning Outcomes / Competencies

The students are able to
- define, differentiate and explain relevant terminology.
- to understand and methodically realize the crucial importance of standardization in information security.
- apply methods, best practices and software tools relevant to practice.
- independently implement project assignments and document results.

3 Course Description and Course Structure

- Depending on the topics actually selected for the respective semester.
- Exemplary topics:
  - Information security management systems: Basics, ISO/IEC 27000 series, Threat modeling, Risk management
  - Operating system security: Capabilities, AppArmor, SELinux, Linux hardening
  - Network security: Firewall systems, Intrusion detection/prevention systems (IDS/IPS)
  - Software security: Penetration testing, Static application security testing (SAST)
  - Hardware security: CPU security, Trusted platform modules (TPM), Smartcards
  - Further topics: Privacy, Biometric systems

The course language is English.

4 Teaching Methods

- Lecture in interaction with the students, with blackboard writing and projection

- individual work

- Project work accompanying the lecture with final presentation

5 Participation Requirements

None

6 Examination Forms

- project work (100%)

7 Requirements for the award of credit points

- successful project work

8 Significance of the grade for the final grade

9	**Module Representative** Prof. Dr. Holger Schmidt **Lecturer** see current course catalog or individual study plan in the Portal of the University of Applied Sciences and Arts Dortmund
10	**Literature** - Depending on the topics actually selected for the respective semester.

Number	Titel
46833	Computer Networks

Language	Duration	Semester	Frequency of offer	Type of module	CP
english	1 Sem.	1 / 2	Summer semester only	Core elective	6

1	Events	Type of event	Planned group size	Workload		HPW
				Contact-hours 60 h	Self-study 120 h	4
-	Computer Networks	Lecture	60			2
-	Computer Networks	Exercise	20			2

2 Learning Outcomes / Competencies

The student aquires the principles (protocols, architectures and applications) in computer networks. She applies technologies for network design on layer 2 and layer 3, for configuration of network components (routers, switches, etc.) and is able to configure and manage computer heterogeneous networks including virtualised network functions. She understands the design and implementation of commmunication protocols and is able to design distributed systems and toplogies with physical and virtual network network components.

By means of practical demonstrations and own acquired expertise she can review typical and approved technologies in data network communications domain including deployment of virtualised network functions.

3 Course Description and Course Structure

- Models for communication systems and other reference models
- Theoretical approaches to capacity planning and dimensioning based on statistical models and Markov chains
- Network algorithms for switching - Spanning Tree Protocol - and Routing - Open Shortest Path First
- Wide Area Network solutions, e.g. Multi Protocol Label Switching
- Virtualised Network Functions using CumulusVX and OPNSense as examples
- Network Management based on SNMP und deployment of Zabbix as network monitoring system
- Reference Architectures for company and data centre networks
- Networking in Cloud Computing

4 Teaching Methods

- lecture in seminar format, with blackboard and projection
- solution of practice-oriented exercises, individually or in teams

5 Participation Requirements

None

6 Examination Forms

written examination

7 Requirements for the award of credit points

passed written examination

8 Significance of the grade for the final grade

9	**Module Representative** Prof. Dr. Stephan Recker **Lecturer** see current course catalog or individual study plan in the Portal of the University of Applied Sciences and Arts Dortmund
10	**Literature** • Larry L. Peterson Bruce S. Davie: Computer Networks: a system approach, 2.ed., Morgan Kaufmann • Douglas Comer / David L. Stevens: Internetworking with TCP/IP, Vol.1 und 2, Prentice Hall

Number	Titel
46908	Usability Engineering

Language	Duration	Semester	Frequency of offer	Type of module	CP
english	1 Sem.	1 / 2	Summer semester only	Core elective	6

1	Events	Type of event	Planned group size	Workload		HPW
				Contact-hours	Self-study	
				60 h	120 h	4
-	Usability Engineering	Lecture	60			2
-	Usability Engineering	Exercise	20			2

2 Learning Outcomes / Competencies

On succesful participation in the module the students are able to:
- reflect on the methodology of their discipline and beyond and to investigate concrete pieces of work with respect to the methods used within (competence bridging subjects)
- develop design solutions systematically and to test their usability
- create research designs, conduct and evaluate the results
- carry out methodological consideration and justify its rationale

Through succesful participation in the module the students
- plan conjointly in small groups an original research project and conduct it as experimenters
- practice the proceedings of common projects

3 Course Description and Course Structure

1. Fundamentals of Usability
2. Relations and Connections to Human-Computer-Interaction
3. Usability Engineering – early approaches
4. Experimental Design and Evaluation Methods
5. Project Phase
6. Special Chapter: Usability with a specific focus on current research subjects

4 Teaching Methods

seminaristic lecture with presentations, group work and assignments

5 Participation Requirements

None

6 Examination Forms

Term Paper and Presentation (80%)
Assignments during term (20%)

7 Requirements for the award of credit points

passed track record consisting of
- Term Paper and Presentation (80%)
- Assignments during term (20%)

8 Significance of the grade for the final grade

9	**Module Representative** Prof. Dr. Christian Reimann **Lecturer** see current course catalog or individual study plan in the Portal of the University of Applied Sciences and Arts Dortmund
10	**Literature** Dix, A., Finlay, J., Abowd, G., Beale, R. (2004): Human-Computer Interaction. Pearson Education Limited. DIN EN ISO 9241 Wilde, T., Hess, T. (2007): Forschungsmethoden der Wirtschaftsinformatik. Wirtsch. Inform. 49, 280–287. Current Research Papers in topics of Usability and User Experience Standardised Questionnaires on topics of Usability and User Experience

Number	Titel
10121	Distributed and Parallel Systems

Language	Duration	Semester	Frequency of offer	Type of module	CP
english	1 Semester	1	Winter semester only	Core elective	6

1	Events	Type of event	Planned group size	Workload		HPW
				Contact-hours	Self-study	
			25	60 h	120 h	4
-	Distributed and Parallel Systems	Seminar Event				4

2 Learning Outcomes / Competencies

Knowledge
- Knows theory of distributed and parallel systems
- Knows critical issues concerning reliable distributed systems
- Knows recent research about partitioning and scheduling for cyber physical systems

Skills
- Can assess the feasibility of distributed CPS
- Can implement algorithms for distributed embedded systems
- Can model the behavior of distributed CPS
- Can apply state of the art tools and can develop new tools for distribution
- Competence - attitude

Competence - attitude
- Can setup tooling and design flows
- Can discuss distribution issues with computer scientists
- Understands the potential of concurrency in CPS

3 Course Description and Course Structure

Distributed systems are groups of networked computers and/or embedded systems, which have a common goal for their work. The terms distributed computing and parallel computing have a lot of overlap and frequently the term concurrent computing is used in this field. There is no clear distinction between them. This course is a prerequisite for the deeper understanding of multicore and manycore systems. It builds the theoretical core knowledge about cyber physical systems (CPS) and about the current state of research in the field of embedded distributed systems.

Course Structure
1. Architectures for distributes systems (in principle)
2. Communication
   1. Synchronous, Asynchronous
   2. Peer-to-Peer, Broadcast, Multicast
   3. Protocols
3. Time and States
   1. States and Timestamps
   2. Clocks
4. Coordination and Agreement
   1. Transactions and Concurrency Control
   2. Deadlocks
   3. Replication and Fault Tolerance
5. Scheduling/Partitioning/Distribution (Multicore/Manycore)
6. Cyber physical systems (CPS)
7. Dependable Systems
8. Programming Paradigms and Methods

	Case Studies CS01: AMALTHEA tool chain – Scheduling & Partitioning tools (e.g. TA tools) Skills trained in this course: theoretical and methodological skills
4	**Teaching Methods** • Lectures & Exercises, AMALTHEA and TA tool labs • e-learning modules on theoretical informatics, tool tutorials
5	**Participation Requirements** None
6	**Examination Forms** • Written Exam at the end of the course (50%) and • individual homework (50%): paper/report about a recent topic from CPS research
7	**Requirements for the award of credit points** Passed exam and passed semester assignments
8	**Significance of the grade for the final grade** 5,00%
9	**Module Representative** Dr. rer. nat. Stefan Henkler Prof. Dr. Carsten Wolff **Lecturer** see current course catalog or individual study plan in the Portal of the University of Applied Sciences and Arts Dortmund
10	**Literature** • G. Coulouris, J. Dollimore, T. Kindberg, G.Blair: Distributed Systems: Concepts and Design (5th ed.), Addison Wesley, May 2011 • Hermann Kopetz, Real-Time Systems: Design Principles for Distributed Embedded Applications (Real-Time Systems Series), Springer, April 2011 • P. Linington, Z. Milosevic, A. Tanaka, A. Vallecillo. Building Enterprise Systems with ODP: An Introduction to Open Distributed Processing, Chapman & Hall/CRC, September 2011 • P. Koopmann. Better Embedded System Software, Drumnadrochit Education, 2010 • Research Papers: Lamport, Chandy & Lamport • Other recent research papers

Number	Titel
46910	Requirements Engineering

Language	Duration	Semester	Frequency of offer	Type of module	CP
english	1 Sem.	1 / 2	Winter semester only	Core elective	6

1	Events	Type of event	Planned group size	Workload		HPW
				Contact-hours	Self-study	
				60 h	120 h	4
-	Requirements Engineering	Lecture	60			2
-	Requirements Engineering	Exercise	20			2

2 Learning Outcomes / Competencies

After successfully completion of the module, students are able to:

Knowledge and understanding:

- explain the role of requirements engineering (RE) in the context of today's challenges in projects, e.g. the "VUCA world" (volatility, uncertainty, complexity, ambiguity)
- combine different creativity and elicitation techniques appropriately to analyze requirements, as well as to document and validate requirements appropriately
- explain how various activities in RE can be supported with generative AI and where the limits lie

Use, application and generation of knowledge:

- adapt an RE process to an organization and select heuristics, techniques and tools in RE according to characteristics of a project.
- collect, analyze, specify and validate requirements in a goal-oriented manner.
- deal with specific requirements issues such as variability and adaptivity.

Communication and collaboration:

- To learn RE techniques and methods yourself and to convey them to others
- To communicate effectively with different stakeholders, e.g. customers, developers and end users, to develop and refine requirements
- To work together in teams to develop concepts and solutions, balancing different perspectives and interests

Scientific self-image / professionalism:

- To build and lead RE competence in a cross-domain team
- To recognize the ethical and professional responsibility associated with translating the needs of stakeholders into successful systems
- To monitor and critically evaluate RE processes and identify improvement

3 Course Description and Course Structure

Requirements engineering (RE) is the very first activity in software, systems, and service development. Deriving a comprehensive set of requirements is a mandatory and critical task in the early phase of the systems engineering. Requirements are the starting point and main angle for design, programming, verification & validation, and for the test and integration of systems. Project management, configuration and change request management are connected with RE. Defining requirements and dealing with requirements in a structured way is still a major area for research on tools and methodologies. In this module, students will get specific knowledge about the state of the practice and art and the main challenges in RE.

- Introduction to Requirements Engineering
  - Definition, relevance, and challenges
  - Role depending on system types and project characteristics
- Requirements Elicitation
  - Stakeholder identification
  - Interviews, focus groups, and ethnography
  - Brainstorming and collaborative workshops
  - Creativity and innovation
- Requirements Documentation
  - Requirements Specification (SRS) standards
  - Informal methods: prototypes, storyboards
  - Modeling requirements: i-star, UML, user stories
  - Tools: e.g., ReqIF
- Validation and Verification
  - Quality attributes: completeness, consistency, correctness
  - Prototyping and user feedback
  - Requirements testing strategies
- Requirements Management
  - Prioritization techniques: MoSCoW, Kano, Weighted Scoring
  - Traceability matrices
  - Impact analysis for changes
  - Versioning and change management
- Advanced Topics
  - Software product lines, adaptive systems and crowd-based systems
  - Domain-specific languages
  - Generative AI and natural language processing in RE

4 Teaching Methods

- Theoretical knowledge: lectures on requirements engineering
- Practical Skills: requirements engineering cycle, group work to train concepts and methods, to develop skills and to work on case studie
- Scientific Competences: research paper on literature review about RE topic

5 Participation Requirements

None

6 Examination Forms

- written examination (70%)
- examinations taken during the course of a semester (30%)

7 Requirements for the award of credit points

- passed written examination
- successful mini-project (project-related work)

8 Significance of the grade for the final grade

9 Module Representative

Prof. Dr. Erik Kamsties

Lecturer
see current course catalog or individual study plan in the Portal
of the University of Applied Sciences and Arts Dortmund

10 Literature

Basics & Practitioner

Pohl, K.; Requirements Engineering: Fundamentals, Principles, and Techniques, 2nd edition, Springer 2025.
Handbook on Natural Language Processing for Requirements Engineering . Ferarri, A.; Ginde, G.; (editors), Springer 2025
Dick, J.; Hull, E.; Jackson, K.; Requirements Engineering 4th Edition, Springer, 2017.
Ramachandran, M.; Zaigham, M.; Requirements Engineering for Service and Cloud Computing, Sprin- ger, 2017
Laplante, P. A.; Requirements Engineering for Software and Systems (Applied Software Engineering Series), 3rd Edition, Auerbach Publications, 2017
Pohl, K., Rupp, C., Pohl, K.: Requirements engineering fundamentals: a study guide for the certified professional for requirements engineering exam; foundation level - IREB compliant. Rocky Nook, Santa Barbara, California, USA (2015).
Robertson, S. and Robertson, J.; Mastering the Requirements Process: Getting Requirements Right, Addison-Wesley, 2012

Research (Conferences, Journals & selected articles)

- Working Conference on Requirements Engineering: Foundation for Software Quality (REFSQ)
- IEEE International Requirements Engineering Conference (RE)
- Requirements Engineering Journal, Springer
- International Workshop on Requirements Engineering and Testing, at ICSE International Conference on Software Engineering, IEEE Press
- IEEE Transactions on Software Engineering
- IEEE Systems Journal
- Groen, E.C., Seyff, N., Ali, R., Dalpiaz, F., Doerr, J., Guzman, E., Hosseini, M., Marco, J., Oriol, M., Perini, A., Stade, M.: The Crowd in Requirements Engineering: The Landscape and Challenges. IEEE Softw. 34, 44–52 (2017). https://doi.org/10.1109/MS.2017.33.

Number	Titel
46839	Machine Learning

Language	Duration	Semester	Frequency of offer	Type of module	CP
english	1 Sem.	1 / 2	Summer semester only	Core elective	6

1	Events	Type of event	Planned group size	Workload		HPW
				Contact-hours 60 h	Self-study 120 h	4
-	Machine Learning	Lecture	60			2
-	Machine Learning	Exercise	20			2

2 Learning Outcomes / Competencies

The course deals with the development and analysis of machine learning methods in applications of computer science, medical informatics and general information systems. After successful participation in the course, students will have acquired the following competences:

Knowledge:
- know the most important technical terms of machine learning and can use them to explain learning systems.
- They can implement and evaluate the use of machine learning methods for their own application tasks. To this end, students are familiar with typical applications of these methods.
- are familiar with project management methods for machine learning applications such as CRISP-DM
- know explanatory components for machine learning and can interpret the results
- are familiar with typical problems of machine learning such as overfitting and information leakage and can avoid them
- know the theoretical limits of machine learning systems and can describe them formally and use them to assess the limits of their own applications.

Skills
- can design, implement and analyse machine learning systems for specific application contexts in computer science.
- can scrutinise and discuss the ethical foundations and limits of machine learning systems
- can select suitable machine learning methods for applications
- can implement simple deep learning solutions with JupyterHub
- can independently plan, implement, analyse and document mini-projects with an industrial reference in a team

Competences (personal and social skills)
- can formulate ideas and proposed solutions orally and in writing
- can solve tasks in exercises and practicals independently and present the results
- can independently develop and present theoretical content on the topic of machine learning from scientific literature
- can develop solutions cooperatively in the exercise and project phases
- can cooperatively plan, distribute and jointly carry out tasks for solutions in the project phases
- can argue in discussions in a goal-oriented manner and deal with criticism objectively
- can present the results of group work together
- can evaluate project results and formulate suggestions for improvement
- can recognise and resolve misunderstandings between discussion partners

3 Course Description and Course Structure

- Basic concepts of machine learning
- Use of KNime for machine learning
- Design of evaluation studies for machine learning methods and implementation of such studies
- Linear models
- Various models of supervised and unsupervised neural networks

	- Learning methods for structured data: support vector machine, decision trees, random forest, gradient boosting machines (GBM) - Nearest neighbour methods, lazy learning and embeddings - Bayesian networks - Unsupervised learning methods (k-means) - Combination models (ensembles, boosting machines) - Deep learning models (convolutional neural networks (CNN), long short-term memory (LSTM), transformer architectures e.g. BERT, visual transformer) - Deep learning concepts - transfer learning, data augmentation, generative adversarial networks (GAN) - Deep learning - parallelisation with GPUs, implementation on mobile platforms with low resources - Theoretical concepts: Bias-variance dilemma, no free lunch theorem - Explainability of models - Applications with data from different modalities (text, image, sound), Word2Vec, FastText, Transformer - Large Language Models and use of Embeddings, Retrieval Augmented Generation (RAG) - Methods for improving generalisation performance (regularisation, feature selection, dimension reduction, complexity adjustment) - Problem solving using the example of study programme-related mini-projects from industrial applications (student mini-projects in teams of 2-3)
4	**Teaching Methods** • lecture in seminar format, with blackboard and projection • Processing of programming tasks on the computer in individual or team work • lecture accompanying project work with final presentation • Flip teaching (inverted classroom)
5	**Participation Requirements** None
6	**Examination Forms** • written examination (70% of the necessary examination performance) • examinations taken during the course of a semester (30% of the necessary examination performance, presentation of the miniproject)
7	**Requirements for the award of credit points** • passed written examination • successful examination during the semester (presentation of mini-project (project-related work)
8	**Significance of the grade for the final grade**
9	**Module Representative** Prof. Dr.-Ing. Christoph M. Friedrich **Lecturer** see current course catalog or individual study plan in the Portal of the University of Applied Sciences and Arts Dortmund
10	**Literature** - I. Witten, E. Frank, M. Hall und C. J. Pal, Data Mining: Practical Machine Learning Tools and Techniques, 4. Auflage, Morgan Kaufmann (2017) - electronic version available from the library - C. M. Bishop, Pattern Recognition and Machine Learning, Springer (2006) - E. Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning), Revised and Updated Edition, MIT Press (2021) - I. Goodfellow, Y. Bengio und A. Courville: Deep Learning, MIT Press (2016)

Number	Titel
46801	Advanced Regression Methods

Language	Duration	Semester	Frequency of offer	Type of module	CP
bilingual (en/de)	1 Sem.	1 / 2	Winter semester only	Core elective	6

1	Events	Type of event	Planned group size	Workload		HPW
				Contact-hours	Self-study	
				60 h	120 h	4
-	Applied Statistics	Lecture	60			2
-	Applied Statistics	Exercise	20			2

2 Learning Outcomes / Competencies

After successfully completing the module, students will be able to extract information from data using regression methods. They will be able to independently recognize which type of statistical model from the field of regression analysis is suitable for a problem and name the model assumptions. They can use suitable software to adapt a model to data sets and explain which method is used for parameter estimation and model selection. Students can set up a statistical design of experiment for a screening or optimization task, collect and analyze data themselves and prepare documentation in report form.

3 Course Description and Course Structure

The module teaches assumptions and definitions of various statistical models from the field of regression models. In addition to classic linear models, analysis of variance, generalized linear models and Gaussian process models are also covered. The entire process of statistical data analysis is covered, starting with model assumptions, hypothesis testing, parameter estimation using maximum likelihood and the least squares method, residual analysis, variable selection, through to model interpretation and prediction and prediction intervals. The basics of statistical experimental designs (experimental design, experimental area, coding, randomization, repetitions, block formation) and various experimental designs (screening and optimization designs, room-filling designs) are taught for the collection of own data set.

4 Teaching Methods

Lecture in seminar style, with blackboard writing and projection, solution of practical exercises in individual or team work, project work accompanying the lecture on practical applications with documentation and presentations

5 Participation Requirements

None

6 Examination Forms

project work with oral examination

7	**Requirements for the award of credit points** succesful project work
8	**Significance of the grade for the final grade**
9	**Module Representative** Prof. Dr. Sonja Kuhnt **Lecturer** see current course catalog or individual study plan in the Portal of the University of Applied Sciences and Arts Dortmund
10	**Literature** • Fahrmeir, L., Künstler, R., Pigeot, I., Tutz, G. (2016), Statistik - der Weg zur Datenanalyse, 8. Aufl., Springer, Berlin. • Fahrmeir, L., Kneib, Th., Lang, S., Marx, B. (2013), Regression: Models, Methods and Applications, Springer, Berlin. • Dobson, A.J., Barnett, A.G. (2018), An Introduction to Generalized Linear Models, 4th edition, Taylor & Francis Ltd, Boca Raton. • Sievertz, K., van Bebber, D., Hochkirchen, Th. (2017) Statistische Versuchsplanung - Design of Experiments (DoE), 4te Auflage, Springer Vieweg, Berlin.

Number	Titel
46859	Formal Methods

Language	Duration	Semester	Frequency of offer	Type of module	CP
english	1 Sem.	1 / 2	Summer semester only	Core elective	6

1	Events	Type of event	Planned group size	Workload		HPW
				Contact-hours 60 h	Self-study 120 h	4
-	Formal Methods	Lecture	60			2
-	Formal Methods	Exercise	20			2

2 Learning Outcomes / Competencies

Formal methods are methods and languages for modeling complex software systems at a certain level of abstraction. Since they have a formal semantics models can be analyzed w.r.t. specified properties. In particular this is important for software-intensive systems.

The course provides knowledge and skills in modeling and analysis of software systems. The students should also be able to choose appropriate languages for the modeling and analysis techniques

Technical and methodological expertise:

- apply the theory of formal methods Formal
- design models, implement them and finally analze their complex strucutre and behavior
- evaluate different methods and formal models with respect to criteria

Self-competence:

- The students can present own ideas and solutions orally and in writing, which foster their self-confidence / competence
- Since the course is given in a seminar like style, the students are encouraged to develop their own strategies for knowledge and knowledge acquisition in combination with additional literature support

Social competence:

- Cooperation and team skills will be trained during the exercise and project phases.
- The students are able to argue objectivley and goal-oriented in duscussion and deal with criticism
- The students can intermedia a scientific disput
- Results of group work can be presented together.

3 Course Description and Course Structure

- Embedding of formal methods in the software development cycle , process models
- Formal methods for program development of complex systems
- Formalisms that are used in today's software tools:
  - Algebraic specification techniques
  - State-based and time-based specifications
  - Dealing with concurrency
- Verification and validation of the software development process
- Formal specification languages
- Tools for formal program development

4 Teaching Methods

- lecture in interaction with the students, using the board and projectors
- lecture in seminar format, with blackboard and projection

	• solution of practice-oriented exercises, individually or in teams
5	**Participation Requirements** None
6	**Examination Forms** • written examination (70%, 90min) • semester assignments: group work as homework (30%)
7	**Requirements for the award of credit points** • passed written examination • passed semester assignments
8	**Significance of the grade for the final grade**
9	**Module Representative** Prof. Dr. Martin Hirsch **Lecturer** see current course catalog or individual study plan in the Portal of the University of Applied Sciences and Arts Dortmund
10	**Literature** • Reisig, W. (2013): Understanding Petri Nets – Modeling Techniques, Analysis Methods, Case Studies, Springer • Clarke, E.M., Grumberg, O., Peled, D.A. (1999): Model Checking, MIT Press • Baier, C., Katoen, J.-P. (2008): Principles of Model Checking, MIT Press • Spivey, J.M. (2001): The Z Reference Manual (https://github.com/Spivoxity/zrm/blob/master/zrm-pub.pdf) • Ruhela, V. (2012): Z Formal Specification Language – An Overview, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) Volume 01, Issue 06 • http://www.tapaal.net • http://www.uppaal.org