MASTER DIGITAL TRANSFORMATION
MASTER PROGRAMME

2020

Module Handbook

Version 19

(StgPO 2020)

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Study Programme overview

1st Semester (Winter Semester)					
Module	**Exam**	**ModNr/ PNr**	**Workload**		
			Contact Time		**Self Study (hours)**
			SWS	**hours**	
Innovation Driven SE	MOD1-01	48010/11	4	60	120
Software Architectures	MOD1-02	48020/21	4	60	120
Digital Systems 1	MOD1-03	48030/31	4	60	120
R&D Project Management	MOD1-04	48040/41	4	60	120
Scientific & Transversal Skills 1	MOD1-05	48050/51	4	60	120
Total	**5**		**20**	**300**	**600**

2nd Semester (Summer Semester)					
Module	**Exam**	**ModNr/ PNr**	**Workload**		
			Contact Time		**Self Study (hours)**
			SWS	**hours**	
Usability Engineering	MOD2-01	48060/61	4	60	120
Software-intensive Solutions	MOD2-02	48070/71	4	60	120
Digital Systems 2	MOD2-03	48080/81	4	60	120
Scientific & Transversal Skills 2	MOD2-04	48090/91	4	60	120
Elective 1 *	MOD2-05	48100	4	60	120
Total	**5**		**20**	**300**	**600**

3rd Semester (Winter Semester)					
Module	**Exam**	**ModNr/ PNr**	**Workload**		
			Contact Time		**Self Study (hours)**
			SWS	**hours**	
Elective 2 *	MOD3-01	48140	4	60	120
Elective 3 *	MOD3-02	48150	4	60	120
Research Project (Thesis)	MOD3-03	48190/91	0	0	540
Total	**3**		**8**	**120**	**780**

4th Semester (Summer Semester)					
Module	**Exam**	**PNr**	**Workload**		
			Contact Time		**Self Study (hours)**
			SWS	**hours**	
Master Thesis and Colloquium	P	103	0	0	900
Total	**1**		**0**	**0**	**900**

[1] SWS= weekly hours per semester

***cf. Attachment 2**

Fachhochschule Dortmund
University of Applied Sciences and Arts

Catalogue of Elective Modules

Catalogue of Elective Modules (Electives 1, 2 and 3)*						
Modul	**Module nr.**	**Exam nr.**	**Workload**			**ECTS**
			Contact hours		**self study (hrs)**	
			SWS	**hours**		
Software Engineering Project	MOD-E01	48201	4	60	120	6
Requirements Engineering	MOD-E02	46910	4	60	120	6
Human Centered Digitalization ***	MOD-E03	48202	4	60	120	6
Formal Methods	MOD-E04	48203	4	60	120	6
Digital Business Ecosystems ***	MOD-E05	48204	4	60	120	6
Trends in Digital Transformation	MOD-E06	48205	4	60	120	6
Information Processing and Data Analytics	MOD-E07	48207	4	60	120	6
Managing Digital Change ***	MOD-E08	48208	4	60	120	6
Smart Home & Smart Building & Smart City	MOD-E09	48209	4	60	120	6
IoT & Edge Computing	MOD-E10	48210	4	60	120	6
Research Seminar	S	48206			180	6
Module(s) from cooperating institutions		48991				
Module(s) from study courses of the home institution**		48992				

* From the Catalogue of Compulsory Electives a minimum of 3 modules must be completed with an examination (MOD2-05, MOD3-01 and MOD3-02). More than 18 credit points may be obtained which will be marked in the certificate.

** If compulsory elective modules of the Ruhr Master School (RMS) are part of the course programmes of Dortmund University of Applied Sciences and Arts (Fachhochschule Dortmund), students must complete the examinations within their own course programme.

Upon application, modules of the course programmes participating in the RMS may be elected.

*** At least 1 of the following Modules must be taken as an Elective: MOD-E03, MOD-E05, or MOD-E08.

Innovation Driven Software Engineering (MOD1-01)

Code Number	Workload	Credits	Semester	Frequency	Duration
48010/11	180 h	6	1	winter semester	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	Innovation Driven Software Engineering	4 SWS / 60 h	120 h	25 students

2 Course Description

Innovation driven software engineering touches every aspect of modern software development. Today's software emphasizes novelty, usability, and joy of use. Modern software is usually created in creative and highly iterative processes. Many steps in these processes involve potential users. This integration of the user can be addressed with the so-called Design Thinking method.

Refined ideas and prototypes can be the foundation for new startup companies. One way to check the viability is the Business Model Canvas. Agile Software Development puts the focus back on user feedback and iterations. The agile development process is accompanied with an extensive tool chain for designing and creating software solutions. For instance, UML Diagrams, Version control systems, Bug tracker and ticket management systems.

3 Course Structure

- Design Thinking
- Business Model Canvas
- Legacy process models
- Agile Software Development
- Agile Manifesto best practices
- UML Modelling
- Tooling like git, Bug tracker and ticket management systems, Checkstyle, etc.

4 Application Focus

- Practical exercises
- Realizing a real-world project within a block-week in a team

5 Scientific Focus

- Written assignment: literature review in the style of a scientific paper up to 10 pages
- Performing a survey based on relevant scientific methods

6 Parameters

- ECTS: 6
- Hours of study in total: 180
- Weekly hours per semester: 4
  - Contact hours: 60
  - Self-Study hours: 120
- Course characteristics: compulsory
- Course frequency: every year – winter semester

	• Maximal capacity: 25 students • Course admittance prerequisites: none • Skills trained in this course: theoretical knowledge, practical skills and scientific competencies • Assessment of the course: Theoretical knowledge (40%): Written Exam at the end of the course, Practical Skills (40%): realizing a small real-world project within the lecture related topics of innovation driven software engineering and Scientific Competences (20%): written paper (literature review, approx. 10 pages) and presentation (in class or at a student conference, e.g. International Research Conference Dortmund) • Teaching staff: Prof. Dr. Sabine Sachweh, external lecturers from industry and/or partner universities, PhD students from IDiAL
7	**Learning outcomes** 7.1 Knowledge • Knows the theoretical background of the design thinking method • Knows different software development processes especially agile software development • Knows required steps and processes for agile software development • Knows how to express software architectures based on the UML Diagrams • Knows how to use tools like git, checkstyle, bug tracking and issue management systems 7.2 Skills • Can conceptualize a software based on the design thinking method • Can apply and choose between software development processes • Can setup and manage a team based on agile principles • Can work on a software development project 7.3 Competence – attitude • Can work in a team on scientific topics • Can present and defend scientific results in front of an audience • Can discuss the topics related to the lecture • Can understand related topics and translate between different domains
8	**Teaching and training methods** • Theoretical knowledge: e-learning modules on innovation driven software engineering • Practical Skills: Project work, Labs, and Exercises • Scientific Competences: extract information for a given topic in a small group and sum the results up
9	**Course mapping** Input for: MOD2-01 – Usability Engineering MOD-E03 – Human Centered Digitalization Input from: None
10	**References** Basics & Practitioner

	Solving Problems with Design Thinking - Ten Stories of What Works, Jeanne Liedtka, Andrew King, Kevin Bennett, Columbia Business School Publishing, 2013 Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers, Alexander Osterwalder, Yves Pigneur, John Wiley & Sons, 2010 Software Engineering, Ian Sommerville, Addison Wesley Pub Co Inc, 2015 <u>Research (Conferences, Journals and selected papers)</u> ACM Special Interest Group on Design of Communication (SIGDOC) ACM Interactions, e.g. Volume 25 Issue 3, Design Thinking, May/June 2018 Nela Murauer, Design Thinking: Using Photo Prototyping for a user-centered Interface Design for Pick-by-Vision Systems. In Proceedings of the 11th PErvasive Technologies Related to Assistive Environments Conference (PETRA '18), 2018 Eunice Sari and Adi Tedjasaputra, Design Thinking 101: A Strategy for Intelligent System Innovation. In Proceedings of the 4th International Conference on Human-Computer Interaction and User Experience in Indonesia, CHIuXiD '18 (CHIuXiD '18), 2018 Corin Walker, Tomeka Nolen, Jinlan Du, and Heather Davis, Applying Design Thinking: In Proceedings of the 2019 ACM SIGUCCS Annual Conference (SIGUCCS '19), 2019 Franziska Dobrigkeit and Danielly de Paula, Design thinking in practice: understanding manifestations of design thinking in software engineering. In Proceedings of the 2019 27th ACM Joint Meeting on European Software Engineering Conference and Symposium on the Foundations of Software Engineering (ESEC/FSE 2019), 2019

Software Architectures (MOD1-02)

Code Number	Workload	Credits	Semester	Frequency	Duration
48020/21	180 h	6	1	winter semester	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	Software Architectures	4 SWS / 60 h	120 h	25 students

2 Course Description

In recent years' new architectural styles have emerged to cope with the increasing need of highly scalable and distributed systems. Among them are Microservices and Self-Contained Systems. The resulting systems are characterized by being componentized into independent services which communicate using well-defined interfaces.

This course the students learn about modern software architecture paradigms, both conceptually and practically. Additionally, subjects related to the operation of such systems are covered, such as infrastructure-technologies and particular challenges of operation like scaling or load balancing.

In addition to the lectures, the students have the opportunity to apply their knowledge in project-based group activities.

3 Course Structure

- Historical development of software architecture paradigms.
- Characteristics of modern architectural styles.
- Designing Microservices and Self-Contained Services.
- Developing Microservices and Self-Contained Services.
- Infrastructure, deployment, and operation: Methods, technologies and challenges.

4 Application Focus

To complement the lectures and enable the students to apply the covered topics, there will be a project. Their students will work in small groups to participate in the design and development of a significant application.

5 Scientific Focus

Written assignment: literature review in the style of a scientific paper up to 10 pages
Performing a survey based on relevant scientific methods

6 Parameters

- ECTS: 6
- Hours of study in total: 180
- Weekly hours per semester: 4
  - Contact hours: 60
  - Self-Study hours: 120
- Course characteristics: compulsory
- Course frequency: every year – winter semester

	• Maximal capacity: 25 students • Course admittance prerequisites: none • Skills trained in this course: theoretical knowledge, practical skills and scientific competencies • Assessment of the course: Theoretical knowledge (40%): Theoretical knowledge (40%): Written Exam at the end of the course, Practical Skills (40%): Individual programming task, realizing a small real-world project within the lecture related topics of software architectures and Scientific Competences (20%): written paper (literature review, approx. 10 pages) and presentation (in class or at a student conference, e.g. International Research Conference Dortmund) • Teaching staff: Prof. Dr. Sabine Sachweh, external lecturers from industry and/or partner universities, PhD students from IDiAL
7	**Learning outcomes** 7.1 Knowledge • Knows the concepts and structure of modern software architecture styles • Knows technologies and tools related to the operation of modern software architectures • Knows particular challenges of operating distributed systems • Knows how to analyze an application by different metrics • Knows to maintain and operate a distributed system • Knows how to distributed a system based on workload of particular components 7.2 Skills • Can critically evaluate the suitability of an architectural style given a particular problem • Can design, develop and operate leveraging the lecture topics • Can assess and improve an existing software architecture • Can analyze a distributed system by different application metrics • Can distribute a container-based system by workload 7.3 Competence – attitude • Can discuss and assess the differences between various architectural styles • Can communicate and explain architectural decisions • Can work in a team on scientific topics • Can demonstrate and discuss results in a group
8	**Teaching and training methods** • Theoretical knowledge: e-learning modules on software architecture models, tool tutorials • Practical Skills: Projects, Labs & Exercises, small project • Scientific Competences: student research group on SW Architectures
9	**Course mapping** Input for: MOD2-02 – Software-intensive Solutions MOD-E01 – Software Engineering Project Input from: None
10	**References** Basics & Practitioner

	Newman, S.; Building Microservices, O'Reilly Media, 2016 Newman, S.; Monolith to Microservices: Evolutionary Patterns to Transform Your Monolith, O'Reilly Media, 2019 Wolff, E.; Microservices: Flexible Software Architecture, Addison-Wesley, 2016 Chris Richardson, Microservices Patterns: With examples in Java, Manning Publications, 2018 Research (Journals, Conferences & selected papers) Microservices Conference, https://www.conf-micro.services/ , e.g. 2019, FH Dortmund IEEE Software IEEE Transactions on Software Engineering F. Rademacher, J. Sorgalla and S. Sachweh, "Challenges of Domain-Driven Microservice Design: A Model-Driven Perspective," in IEEE Software, vol. 35, no. 3, pp. 36-43, May/June 2018 L. De Lauretis, "From Monolithic Architecture to Microservices Architecture," 2019 IEEE International Symposium on Software Reliability Engineering Workshops (ISSREW), Berlin, Germany, 2019

Digital Systems 1 (MOD1-03)

Code Number	Workload	Credits	Semester	Frequency	Duration
48030/31	180 h	6	1	winter semester	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	Digital Systems 1	4 SWS / 60 h	120 h	25 students

2 Course Description

The module is intended to give students to competence to understand, analyze, develop, set up and evaluate digital systems based on the latest scientific state of the art. This involves the basic layers of the Internet-of-Things (IoT) stack including M2M devices and gateways, the relevant protocol stacks for IoT and the relevant communication network technologies (both wireless and wireline). During the module, students will set up a complete IoT device with all relevant functionality to be connected to the cloud. Recent topics from research projects (e.g. connected car, smart home) complement the course with the aim to stimulate discussion of scientific results.

3 Course Structure

1. Introduction to M2M and IoT devices and gateways
2. Processor architecture for embedded devices and gateways
3. IP based communication
4. IoT and M2M protocols
5. Communication gateway architectures
6. Wireline communication networks and standards
7. Wireless communication networks and standards
8. Case study of a state-of-the-art application, e.g. connected car or industry 4.0

4 Application Focus

Project IoT System: students will set up and implement a IoT system with an M2M device, a gateway with wireless and wireline transmission and a IoT cloud connection. The respective case study will be taken from a recent R&D project or an industry case. The result will be a demonstrator system.

Trainings: students attend a training for the Siemens Embedded Software Developer tool chain

5 Scientific Focus

Students will do a scientific evaluation of the potential of IoT usage in a specific domain (e.g. eMobility charging systems) based on recent scientific literature.

6 Parameters

- ECTS: 6
- Hours of study in total: 180
- Weekly hours per semester: 4
  - Contact hours: 60
  - Self-Study hours: 120

	• Course characteristics: compulsory • Course frequency: every year – winter semester • Maximal capacity: 25 students • Course admittance prerequisites: none • Skills trained in this course: theoretical knowledge, practical skills and scientific competencies • Assessment of the course: Theoretical knowledge: Written Exam at the end of the course (50%) and Practical Skills: Individual programming task (50%): implementation of an IoT device, gateway and protocol stack system => demonstration of the result • Teaching staff: Prof. Dr. Ingo Kunold, staff from IKT institute, guest lecturers from joint research projects
7	**Learning outcomes** 7.1 Knowledge • Knows relevant theoretical foundations of M2M and IoT • Knows relevant gateway and processor architectures • Knows relevant protocol stacks and communication systems • Know methodical background of IoT system design • Is aware of critical limitations of IP based protocols, esp. in real time tasks 7.2 Skills • Can model IoT and M2M systems • Can implement embedded systems into IoT systems • Can apply state of the art tools for SW for embedded systems • Can select IoT and M2M platforms according to system requirements 7.3 Competence – attitude • Can discuss IoT device and gateway systems with experts • Can lead cross domain design for IoT systems • Understands SW and HW experts and translates between different domains
8	**Teaching and training methods** • Theoretical knowledge: e-learning modules on IoT devices and protocols, tool tutorials • Practical Skills: Projects, Labs & Exercises, small project with an IoT device and protocol stack • Scientific Competences: own research on IoT in e-mobility
9	**Course mapping** Input for: MOD2-03 – Digital Systems 2 Input from: none
10	**References** <u>Basics & Practitioner</u> Andrew S. Tanenbaum, David J. Wetherall: Computer networks, 2014 Peter Prinz, Tony Crawford, C in a Nutshell, 2nd Edition, 2015 Herbert Schildt, Java: The Complete Reference, Eleventh Edition

K.C. Wang, Embedded and Real-Time Operating Systems, 2017

OWASP Foundation, „Open Web Application Security Project,“, [Online] Available: https://www.owasp.org/index.php/Main_Page

BSI - Federal Office for Information Security, “Protection profile for the gateway of a smart metering system,” 2014, [Online] Available: https://www.bsi.bund.de

BSI - Federal Office for Information Security, “BSI TR-03116-4,” 2012, [Online] Available: https://www.bsi.bund.de

„RFC 4253: The Secure Shell (SSH) Transport Layer Protocol“, [Online] Available: https://tools.ietf.org/html/rfc4253

„RFC 7252: The Constrained Application Protocol (CoAP)“, [Online] Available: *https://tools.ietf.org/html/rfc7252*

W3C, „Web of Things (WoT) Thing Description,“ 16 May 2019. [Online]. Available: https://www.w3.org/TR/wot-thing-description/.

OpenAPI Specification (Version 2.0), [Online] Available: https://swagger.io/specification/v2/

Research (Examples for selected papers)

M. Niemeyer und I. Kunold, „Security Aspects of Cyber Physical Systems and Services,“ in *Smart Energy 2016 Digitalisierung der Energieversorgung — Treiber und Getriebene*, Dortmund, vwh, 2016.

B. M. H. Alhafidh, W. H. Allen, “High Level Design of a Home Autonomous System Based on Cyber Physical System Modeling”, IEEE 017 IEEE 37th International Conference on Distributed Computing Systems Workshops (ICDCSW), July 2017

Hoeller and R. Toegl, “Trusted Platform Modules in Cyber-Physical Systems: On the Interference Between Security and Dependability “, 2018 IEEE European Symposium on Security and Privacy Workshops (EuroS&PW), London, 2018, pp. 136-144.

R&D Project Management (MOD1-04)

Code Number	Workload	Credits	Semester	Frequency	Duration
48040/41	180 h	6	1	winter semester	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	R&D Project Management	4 SWS / 60 h	120 h	25 students

2 Course Description

The course R&D project management is focusing on processes, methods and tools for the management of innovative research and development projects in engineering. R&D projects are characterized by creativity and a high degree of innovation and uncertainty. Advanced project management methodology has to deal with the uncertainty and has to foster creativity. Apart from this general problem, R&D project methodology has to be aligned with the engineering processes and with the different engineering domains. Topics like quality management, configuration management and specific tools for risk management are part of the methodology, too. The course enables students to understand and structure R&D projects and to choose appropriate tools and methods based on a proper analysis of the project characteristics. The students are able to tailor the methodology and they understand the remaining gaps in the methodology. They can develop new project management methods and tools to fill the gaps and they can do research to assess the effectiveness and efficiency of project management methodology in R&D. The course is based on one main project case study and several small cases for specific topics.

3 Course Structure

1. Characteristics of R&D projects
2. Project management processes:
    a. planning, controlling (cost, time, quality)
    b. agile & lean
    c. V-model
3. Milestones and Reviews
4. Risk Management for R&D Projects
5. Configuration & Release Management
6. Change and Claim Management (incl. Patents)
7. Quality Management (incl. CMMI)
8. KPIs and Scorecards
9. Large R&D projects and Cross Domain Projects
10. Management of R&D organizations

4 Application Focus

Block workshop: students attend an interdisciplinary one-week workshop where they prepare and plan a project for an industry case (together with EuroMPM and Master ESM)

5 Scientific Focus

	Students prepare a homework and a presentation on an individually selected topic from recent project management research.

6	**Parameters**
	• ECTS: 6
	• Hours of study in total: 180
	• Weekly hours per semester: 4
	  – Contact hours: 60
	  – Self-Study hours: 120
	• Course characteristics: compulsory
	• Course frequency: every year – winter semester
	• Maximal capacity: 25 students
	• Course admittance prerequisites: none
	• Skills trained in this course: theoretical knowledge, practical skills and scientific competencies
	• Assessment of the course: Theoretical knowledge: Oral exam at the end of the course (40%), Practical Skills: Group assessment on results of block week (40%) and Scientific Competences: paper presentation (20%)
	• Teaching staff: Prof. Dr. Carsten Wolff, Dr. Oliver Hempel (Industry Lecturer Honeywell Elster)

7	**Learning outcomes** 7.1 Knowledge • Students know the basic body of knowledge for project management • Students know processes, methods and tools for risk management for R&D projects (e.g. FMEA, @risk) • Students know processes, methods and tools for configuration management (esp. from SW engineering) • Students know processes, methods and tools for change and claim management • Students know processes, methods and tools for quality management according to ISO9001 and TS16949 • Students understand the importance of Reviews in R&D projects • Students understand the main challenges of large R&D projects 7.2 Skills • Students can tailor processes and methods to the respective projects • Students can apply the respective project management methodology • Students can assess R&D projects and can extract relevant characteristics • Students can develop new methods according to gaps in the existing methodology • Students can do the complete planning and preparation of a real project case • Students can develop relevant KPIs and scorecards for measuring effectiveness and efficiency 7.3 Competence – attitude • Students develop an attitude to project management according to engineering standards • Students show a quality attitude according to engineering standards • Students manage projects based on structured and well-defined processes and in-depth analysis • Students can achieve high effectiveness and efficiency in running complex and innovative R&D projects • Students understand the differences between small and large projects and act accordingly

8	**Teaching and training methods** • Theoretical knowledge: lectures on project management processes, methods and tools • Practical Skills: interdisciplinary block week • Scientific Competences: individual research paper + presentation
9	**Course mapping** Input for: Usability Engineering (MOD2-01) Requirements Engineering (MOD-E02) Managing Digital Change (MOD-E08) Input from: none
10	**References** <u>Basics</u> PMBOK® Guide - 6th edition, PMI® 2017 ICB - IPMA Competence Baseline, Version 4, PMA/GPM- Eigenverlag 2015 Kerzner, Harold: Project Management: A Systems Approach to Planning, Scheduling, and Controlling, 10th edition, New York 2009 <u>Practitioner:</u> INCOSE Systems Engineering Handbook: A Guide for System Life Cycle Processes and Activities, 4th Edition, INCOSE, 2015, ISBN: 978-1-118-99940-0 Design Thinking Revolution, independently published, 2020 Agile Project Management with Kanban (Best Practices), Microsoft Press, 2015 <u>Research (Conferences, Journals, selected Articles)</u> • IPMA Research Conference • IPMA World Congress • International Scientific Conference on Project Management, Riga, Latvia • ACM ICSE, International Conference on Software Engineering • ACM SIGSOFT Software Engineering Notes Towards effective AI-powered agile project management, Dam, Hoa Khanh and Tran, Truyen and Grundy, John and Ghose, Aditya and Kamei, Yasutaka, in Proceedings of the 41st International Conference on Software Engineering: New Ideas and Emerging Results, IEEE Press 2019 Data Mining of Project Management Data: An Analysis of Applied Research Studies, Ertek, Gurdal and Tunc, Murat Mustafa and Zhang, Allan Nengsheng and Tanrikulu, Omer and Asian, Sobhan, in Proceedings of the 2017 International Conference on Information Technology, Singapore, ACM, 2017

Scientific & Transversal Skills 1 (MOD1-05)

Code Number	Workload	Credits	Semester	Frequency	Duration
48050/51	180 h	6	1	winter semester	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	Scientific & Transversal Skills 1	4 SWS / 60 h	120 h	25 students

2 Course Description

The course is intended to form a tailored program for new students according to their prior knowledge, educational and professional background. It is intended to offer a wrap up and to close gaps according to the previous bachelor degree, to converge the students from different backgrounds into one international classroom and to prepare them for the educational concepts of the Master's program. Students select compact courses worth 6 ECTS in total on topics relevant for the further study program. These compact courses will enable students with different backgrounds to get a smooth start into the other master modules. The selection of courses is need based and will be assessed by interviewing the students, by doing tests (where necessary) and by consulting.

3 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 Electronics Course (Microcontroller-Lab)
2. Compact Programming Course (Java, C#)
3. Modeling of Embedded Systems (UML)
4. Tools and Techniques for Digital Systems Design (Eclipse)
5. Mini Projects (Group Projects, with other Master's programs)
6. Research Methods and Tools – part A (RMT-A): (Introduction to Scientific Domain, Literature Review, Conceptual Frameworks)
7. International Project Communication (English)
8. Engineering Communication 1 (German A1, or other foreign language for Germans)

4 Application Focus

Depending on choice of courses

5 Scientific Focus

Depending on choice of courses

6 Parameters

- ECTS: 6
- Hours of study in total: 180
- Weekly hours per semester: 4
  - Contact hours: 60
  - Self-Study hours: 120

	• Course characteristics: compulsory • Course frequency: every year – winter semester • Maximal capacity: 25 students • Course admittance prerequisites: none • Skills trained in this course: Depending on choice of courses • Assessment of the course: Depending on choice of courses • Teaching staff: Prof. Dr. Rolf Schuster, PhD students of IDiAL for compact courses, external Professor from partner university for “Research methodology 1”, language trainers and coaches e.g. from Auslandsgesellschaft
7	**Learning outcomes** 7.1 Knowledge • Knows the foundations of each topic at least up to bachelor knowledge 7.2 Skills • Can apply the knowledge in the upcoming master courses 7.3 Competence – attitude • Can assess the gaps in own knowledge • Can use a variety of tools, online-courses, tutorials to close the gap in own responsibility
8	**Teaching and training methods** Compact courses will follow a similar structure: - 1 day introduction in the first two weeks of the first semester, mini-tests to assess the prior knowledge and to define the gap. Definition of the training need and selection of trainings and exercises - 0,5 day assessment and tutorial in the week before Christmas (block week) - Tutorials on each Friday throughout the whole semester - Access to e-learning modules and MOOCs for each topic - Literature recommendations and provision of exercises - Submission of homework for assessment and advice by tutors Language and communication trainings will be done on a weekly basis, e.g. Monday afternoon + evening (in connection with external trainers, e.g. from Auslandsgesellschaft), external lecturer for “Research Methods and Tools – part A (RMT-A)”
9	**Course mapping** Input for: Depending on choice of courses Input from: none
10	**References** Depending on the chosen set of compact courses. For example: 1. Compact Electronics Course (Microcontroller-Lab) • Basic Electronics for Scientists and Engineers, Cambridge University Press, 2011 2. Compact Programming Course (Java, C#) • Java: The Complete Reference, Eleventh Edition, McGraw-Hill Education, 2018

	• Java in a Nutshell: A Desktop Quick Reference, Evans & Flanagan, O'Reilly Media, 2018 3. Modeling of Embedded Systems (UML) • Model-Based Systems Engineering with OPM and SysML, Dov Dori, Springer, 2016 • Software Engineering for Embedded Systems: Methods, Practical Techniques, and Applications, Newnes, 2019 • Modelling software with pictures: Practical UML diagramming for real-time systems, Jim Cooling, Independently published, 2018 4. Tools and Techniques for Digital Systems Design (Eclipse) • Eclipse Plug-in Development: Beginner's Guide - Second Edition, Blewitt, Packt Publishing, 2016 5. Mini Projects (Group Projects, with other Master's programs) 6. Research Methods and Tools – part A (RMT-A): (Introduction to Scientific Domain, Literature Review, Conceptual Frameworks) • Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, Creswell, SAGE Publications, 5th Edition, 2018 7. International Project Communication (English) 8. Engineering Communication 1 (German A1, or other foreign language for Germans)

Usability Engineering (MOD2-01)

Code Number	Workload	Credits	Semester	Frequency	Duration
48060/61	180 h	6	2	summer semester	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	Usability Engineering	4 SWS / 60 h	120 h	25 students

2 Course Description

The course Usability Engineering is focusing on the essential methods and tools to evaluate and measure the effectiveness, efficiency and the joy of use with which a user and perform a task with a given system. The reoccurring scheme throughout the course is the User Centered Design Process. Students will learn how to observe and specify a context of use, derive requirements from it, create a prototype and evaluate it. For all those parts of the processes specific tools and methods will be introduced, for different phases during the software development. Students will learn about the work in the area of usability engineering from a theoretical viewpoint, by studying state-of-the-art research publications, as well as from a practical point of view, by project examples and case studies. These methods and tools will be applied as well as critically evaluated and checked for potential of improvement.

3 Course Structure

1. Introduction
   a. Motivation
   b. Definition Usability Engineering
2. Processes
   a. Usability Engineering -Processes
   b. Integration into IT-projects
   c. Potential conflicts
   d. Communicating Usability
3. Usability Engineering Tools and Methods
   a. Analyzing context of use
   b. Requirements management
   c. Concepts
   d. Evaluation
4. Additional topics:
   Coordinated with the student's interests one to three of the following topics will be chosen. The list will be adapted to take changes in the state of the art into account.
   a. Mobile Computing
   b. Individual software solutions
   c. Consumer- vs. Business-Software
   d. Industrial solutions

4 Application Focus

Block workshop: students attend an interdisciplinary one-week workshop where they apply the Usability Tools and Methods for an industry case (potentially together with EuroMPM, Master

	ESM and Master Computer Science), for example in an early project state with prototyping or in a later project state with focus on evaluation and last changes
5	**Scientific Focus** Students prepare a homework and a presentation on an individually selected topic from recent usability engineering research, related to the project they worked on during the block workshop for the application focus, including a reflection on the lessons learned from practice in comparison to research.

6	**Parameters**
	
	• ECTS: 6
	• Hours of study in total: 180
	• Weekly hours per semester: 4
	  – Contact hours: 60
	  – Self-Study hours: 120
	• Course characteristics: compulsory
	• Course frequency: every year – summer semester
	• Maximal capacity: 25 students
	• Course admittance prerequisites: none
	• Skills trained in this course: theoretical knowledge, practical skills and scientific competencies
	• Assessment of the course: Theoretical knowledge (40%): Written or oral Exam at the end of the course, Practical Skills (40%): realizing a small real-world project using usability engineering tools and methods during a block week and Scientific Competences (20%): written paper (literature review, approx. 10 pages) and presentation (in class or at a student conference, e.g. International Research Conference Dortmund)
	• Teaching staff: Prof. Dr. Christian Reimann, external lecturers from partner universities, e.g. Prof. Dr. Rimante Hopiene (Technische Universität Kaunas, KTU, Litauen)

7	**Learning outcomes** 7.1 Knowledge • Knows relevant theoretical foundations of usability engineering • Knows established usability engineering tools and methods (AB-Tests, GOMS, Interviews, Usability-Lab Tests, Remote-Tests, etc.) • Knows the applicability of those tools and methods in a given project situation • Knows communication concepts for different target groups (professional peers, user groups, management, etc.) 7.2 Skills • Can observe, recognize and evaluate user behavior and behavioral patterns (e.g. analyzing video protocols from user tests) • Can analyze context of use, derive requirements, prototype and evaluate a software system • Can adapt and improve those methods and tools for new application areas • Can develop communication concepts for new/adapted target groups 7.3 Competence – attitude • Can provide a self-reliant evaluation of the recent research in a (small) given area • Can relate and evaluate the methods and tools into the recent scientific publications

	• Can critically reflect behavior (own and well as others) in general, as well as in a given situation
8	**Teaching and training methods** • Theoretical knowledge: e-learning modules and (live-)video lectures on usability engineering • Practical Skills: Projects, Labs & Exercises, block week with selected tools and methods • Scientific Competences: student research group on usability engineering
9	**Course mapping** Input for: • Research Project Thesis (MOD3-03) Input from: • Innovation Driven Software Engineering (MOD1-01) • R&D Project Management (MOD1-04) • Scientific & Transversal Skills 1 (MOD1-05)
10	**References** <u>Basics</u> Jakob Nielsen, Usability Engineering, Elsevier, 1994 Don Norman, The design of everyday things: Revised and Expanded Edition, Basic Books, 2013 <u>Practitioner</u> Carol M. Barum, Usability Testing Essentials, Elsevier, 2010 Jeffrey Rubin and Dana Chisnell, Handbook of Usability Testing: Howto Plan, Design, and Conduct Effective Tests, Wiley, 2008 Steve Krug et al, Rocket Surgery Made Easy: The Do-it-yourself Guide to Finding and Fixing Usability Problems (Voices That Matter), New Riders, 2009 Steve Krug, Don't Make Me Think: A Common Sense Approach to Web Usability (Voices That Matter), New Riders, 2013 The UX Book: Agile UX Design for a Quality User Experience, Morgan Kaufmann, 2019 Usability Assessment: How to Measure the Usability of Products, Services, and Systems, Human Factors and Ergonomics Society, 2016 <u>Research (Journals and Conferences)</u> • ACM SIGCHI, https://dl.acm.org/sig/sigchi/publications • MobileHCI, e.g. MobileHCI '19: Proceedings of the 21st International Conference on Human-Computer Interaction with Mobile Devices and Services • ETRA, e.g. ETRA '19: Proceedings of the 11th ACM Symposium on Eye Tracking Research & Applications • Proceedings of the ACM on Human-Computer Interaction • IEEE Transactions on Human-Machine Systems

Software-intensive Solutions (MOD2-02)

Code Number	Workload	Credits	Semester	Frequency	Duration
48070/71	180 h	6	2	summer semester	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	Software-intensive Solutions	4 SWS / 60 h	120 h	25 students

2 Course Description

This course has the aim to walk through the technology stack of an Internet of Everything (IoE) solution. Students will get a holistic view on the processes, components, methods and tools and their connections and dependencies. Relevant architectures and concepts are put into the context of complete IoE solutions. This holistic view starts with the level of the devices that are connected to the internet like mobile devices or sensors and actuators. Realizing such systems commonly requires the communication with sensors and actuators on the hardware-side and communication with cloud services on the software-side. The corresponding cloud service has to process and store data like sensor values and analyze these with artificial intelligence or machine learning, which must be taken into account while developing such systems. The course intends to put the topics addressed by the first semester modules into the overall context. This forms (as a connecting element) the bridge to the more specific elective modules.

3 Course Structure

- Architectures of Internet of Everything solutions
- APIs for Sensors and Actuators
- Communication protocol stacks and their intergration
- Database integration for IoE (Time-Series etc.)
- Application of Data Science in IoE solutions (Big-Data, Smart Data, etc.)
- Application of Artificial Intelligence and Deep-Learning in IoE solutions
- Integration of cloud-based services

4 Application Focus

Within a block-week real-world project together with companies are realized. Students test and test these projects within the User Innovation Center.

5 Scientific Focus

Written assignment: literature review in the style of a scientific paper up to 10 pages

6 Parameters

- ECTS: 6
- Hours of study in total: 180
- Weekly hours per semester: 4
  - Contact hours: 60
  - Self-Study hours: 120
- Course characteristics: compulsory
- Course frequency: every year – summer semester
- Maximal capacity: 25 students
- Course admittance prerequisites: none

	• Skills trained in this course: theoretical knowledge, practical skills and scientific competencies • Assessment of the course: Theoretical knowledge (40%): Written Exam at the end of the course, Practical Skills (40%): realizing a small real-world project within the lecture related topics of software intensive solutions and Scientific Competences (20%): written paper (literature review, approx. 10 pages) and presentation (in class or at a student conference, e.g. International Research Conference Dortmund) • Teaching staff: Prof. Dr. Sabine Sachweh, external lecturers from industry and/or partner universities, PhD students from IDiAL
7	**Learning outcomes** 7.1 Knowledge • Know the difference between IoT and IoE • Know the different architectures of Internet of Things • Know several related technology stacks • Know the most relevant communication protocols and APIs • Know the requirements of various types of databases • Know the difference between actuating elements, sensors, and devices • Know the purpose of artificial intelligence 7.2 Skills • Can identify and define the requirements for an Internet of Everything application • Can apply different tools for designing an IoE application • Can assess existing solutions in the area of IoE and cloud-services 7.3 Competence – attitude • Can discuss Internet of Everything in the scientific context • Can present and defend results • Can understand and translates IoE related stuff between different domains
8	**Teaching and training methods** • Theoretical knowledge: e-learning modules on software-intensive systems, tool tutorials • Practical Skills: Project work within the User Innovation Center, Labs, and Exercises • Scientific Competences: extract information of published papers about the relevant topics for the provided course-content
9	**Course mapping** Input for: MOD-E01 Software Engineering Project Input from: MOD1-02 Software Architectures MOD1-03 Digital Systems 1
10	**References** Prof. Dr.-Ing. habil. Hartmut Janocha, Adaptronics and Smart Structures, Springer 2007 Taewan You, Toward the future of Internet architecture for IoE, ICTC 2016 Emil Vassev, Mike Hinchey, Awareness in Software-Intensive Systems, IEEE Computer Society 2012

	Marcelo Benites Gonçalves, Everton Cavalcante, Towards a Conceptual Model for Software-Intensive System-of-Systems, ieee international conference on systems, man and cybernetics 2014 Grayson Honan, Tolga Soyata, Internet-of-Everything Oriented Implementation of Secure Digital Health (D-Health) Systems, ISCC 2016

Digital Systems 2 (MOD2-03)

Code Number	Workload	Credits	Semester	Frequency	Duration
48080/81	180 h	6	2	summer semester	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	Digital Systems 2	4 SWS / 60 h	120 h	25 students

2 Course Description

The module is expanding student competence to understand, analyze, develop, set up and evaluate digital systems based on the latest scientific state of the art. This involves mainly the topics security in cyber-physical systems (CPS) and operating systems. During the module, students will develop a security concept for the IoT devices from Digital Systems 1. Furthermore, they will structure an application with real-time requirements according to the operator controller module (OCM) and select an appropriate operating system for the device. Recent topics from research projects (e.g. smart grid, eMobility) complement the course with the aim to stimulate discussion of scientific results.

3 Course Structure

1. Introduction to internet security for CPS
2. Architectures for trusted platforms
3. Secure communication
4. Intrusion detection and advanced methods in CPS
5. Authentication, data protection and privacy and IoT systems
6. Introduction to the Operator-Controller-Module
7. Real-time processing
8. Operating systems (OS) and databases for embedded systems
9. Case study of a state-of-the-art application, e.g. smart grids

4 Application Focus

Project IoT System: students will the security system for the IoT system from the previous semester. Furthermore, they will implement an application with real-time aspects based on a selected operating system. The respective case study will be taken from a recent R&D project or an industry case. The result will be a demonstrator system.

Trainings: students attend a training for CPS security tools from Institute for Internet Security.

5 Scientific Focus

Students will do a scientific evaluation of the security issues in a specific domain (e.g. eMobility charging systems) based on recent scientific literature.

6 Parameters

- ECTS: 6
- Hours of study in total: 180
- Weekly hours per semester: 4

	– Contact hours: 60 – Self-Study hours: 120 • Course characteristics: compulsory • Course frequency: every year – summer semester • Maximal capacity: 25 students • Course admittance prerequisites: none • Skills trained in this course: theoretical knowledge, practical skills and scientific competences • Assessment of the course: Theoretical knowledge: Written Exam at the end of the course (50%) and Practical Skills: Individual programming task (50%): implementation of an IoT security system in device, communication and cloud level (e.g. based on Eclipse IoT stack) => demonstration of the result • Teaching staff: Prof. Dr. Ingo Kunold, staff from IKT institute, guest lecturers from joint research projects
7	**Learning outcomes** 7.1 Knowledge • Knows relevant theoretical foundations of internet security • Knows relevant architectures for trusted platforms • Knows relevant secure communication protocols • Know the theoretical background of the operator controller module (OCM) • Know methodical background of real time system design • Is aware of critical limitations of CPS security and real-time OS 7.2 Skills • Can develop a secure IoT system • Can implement real-time OS into IoT systems • Can apply state of the art tools for CPS security • Can select embedded OS according to system requirements 7.3 Competence – attitude • Can discuss CPS security issues with experts • Can lead cross domain design for IoT systems based on OCM • Understands the connections between cloud security and IoT security
8	**Teaching and training methods** • Theoretical knowledge: e-learning modules on IoT security and operating systems, tool tutorials • Practical Skills: Projects, Labs & Exercises, continuation of the small project with an IoT device, OSGi software architectures, Cloud systems and microservice architectures • Scientific Competences: own research on IoT security issues and, Semantic Web Technologies
9	**Course mapping** Input for: MOD-E09 - Smart Home & Smart Building & Smart City MOD-E10 - Edge Computing Input from: MOD1-03 – Digital Systems 1

10	**References**

Basics & Practitioner

Toby Segaran, Colin Evans, Jamie Taylor, Programming the Semantic Web, August 2009

Bob DuCharme, Learning SQARQL, 2nd Edition, Juli 2013

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ETSI, „TS 103 264 V2.1.1 SAREF version 2 Technical Specification," [Online]. Available: https://www.etsi.org/deliver/etsi_ts/103200_103299/103264/02.01.01_60/ts_103264v020101p.pdf.

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Research (Examples for selected papers)

S. Emerson, Y. Choi, D. Hwang, K. Kim and K. Kim, "An OAuth based authentication mechanism for IoT networks, "2015 International Conference on Information and Communication Technology Convergence (ICTC), Jeju, 2015, pp. 1072-1074.

A. Prasetio, S. R. Akbar, B. Priyambadha, "Implementation of semantic system in the smart home lights device based on agent", IEEE 2017 International Conference on Sustainable Information Engineering and Technology (SIET), Nov. 2017

Y.-H. Son, K. C. Lee, "Cloud of things based on linked data", IEEE 2018 International Conference on Information Networking (ICOIN), April 2018

I. Kunold, H. Wöhrle, M. Kuller, N. Karaoglan, F. Kohlmorgen, J. Bauer, „Semantic Interoperability in Cyber-Physical Systems", The 10th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications 18-21 September, 2019, Metz, France

Scientific & Transversal Skills 2 (MOD2-04)

Code Number	Workload	Credits	Semester	Frequency	Duration
48090/91	180 h	6	2	summer semester	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	Scientific & Transversal Skills 2	4 SWS / 60 h	120 h	25 students

2 Course Description

The course is intended for adding specific scientific and transversal skills to the curriculum. It is intended to prepare students for both a scientific path in the third and fourth semester or for a more application-oriented path with internships and theses in industry. Students select compact courses worth 6 ECTS in total on topics relevant for the further study program. The selection of courses is need based and will be assessed by interviewing the students, by doing tests (where necessary) and by consulting.

3 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 Business Models and Business Cases
2. IT Tools for Projects (Redmine, Jira, Confluence)
3. Mini Projects (Group Projects, with other Master's programmes)
4. Research Methods and Tools – part B (RMT-B) (Research Design, Tools, Databases, Publishing)
5. International Negotiation & Conflict Management (English)
6. Engineering Communication 1 (German A2, or other foreign language for Germans)

4 Application Focus

Depending on choice of courses

5 Scientific Focus

Depending on choice of courses

6 Parameters

- ECTS: 6
- Hours of study in total: 180
- Weekly hours per semester: 4
  - Contact hours: 60
  - Self-Study hours: 120
- Course characteristics: compulsory
- Course frequency: every year – summer semester
- Maximal capacity: 25 students
- Course admittance prerequisites: none
- Skills trained in this course:

	• Assessment of the course: Depending on choice of courses • Teaching staff: Prof. Dr. Rolf Schuster, PhD students of IDiAL for compact courses, external Professor from partner university for “Research Methods and Tools – part B (RMT-B)”, language trainers and coaches e.g. from Auslandsgesellschaft
7	**Learning outcomes** 7.1 Knowledge • Knows the foundations of each topic at least up to bachelor knowledge 7.2 Skills • Can apply the knowledge in the upcoming master courses 7.3 Competence – attitude • Can assess the gaps in own knowledge • Can use a variety of tools, online-courses, tutorials to close the gap in own responsibility
8	**Teaching and training methods** Compact courses will follow a similar structure: - 1 day introduction at the end of the first semester, mini-tests to assess the prior knowledge and to define the gap. Definition of the training need and selection of trainings an exercises - 0,5 day assessment and tutorial in the week before summer school - Tutorials on each Friday throughout the whole semester - Access to e-learning modules and MOOCs for each topic - Literature recommendations and provision of exercises - Submission of homework for assessment and advice by tutors Language and communication trainings will be done on a weekly basis, e.g. Monday afternoon + evening (in connection with external trainers, e.g. from Auslandsgesellschaft)
9	**Course mapping** Input for: Depending on choice of courses Input from: MOD1-05 – Scientific & Transversal Skills 1
10	**References** Depending on choice of courses, for example: 1. Compact Course on Business Models and Business Cases • The Business Models Handbook: Templates, Theory and Case Studies, Paul Hague, Kogan Page, 2019 • Business Model Canvas A Complete Guide - 2020 Edition, Gerardus Blokdyk, 5starcooks, 2020 2. IT Tools for Projects (Redmine, Jira, Confluence)

	• Atlassian Confluence 5 Essentials, 2013 • Jira 8 Essentials: Effective issue management and project tracking with the latest Jira features, 5th Edition, Packt publishing, 2019 • Redmine A Complete Guide - 2019 Edition, Gerardus Blokdyk, 5StarCooks, 2019 3. Mini Projects (Group Projects, with other Master's programmes) 4. Research Methods and Tools – part B (RMT-B) (Research Design, Tools, Databases, Publishing) • Research Methods: A Tool for Life, Bernard C. Beins, Cambridge University Press, 4th Edition, 2018 5. International Negotiation & Conflict Management (English) 6. Engineering Communication 1 (German A2, or other foreign language for Germans)

Research Project (Thesis) (MOD3-03)

Code Number	Workload	Credits	Semester	Frequency	Duration
48190/91	540 h	18	3	winter semester	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	Research Project (Thesis)	0 h	540 h	individual participation

2 Course Description

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.

3 Course Structure

Students will select a topic from one of the ongoing projects or an industry case in Digitalization, Software Engineering and Digital Systems. The 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).

4 Application Focus

The Research Project (Thesis) is done in connection with a research project. It is recommended to do the project and the thesis in connection with an internship/student job in industry or within a research project at a university or research institute, e.g. IDiAL.

5 Scientific Focus

The Research Project (Thesis) is embedded into the scientific activities of the university, especially within the research institutes IDiAL and IKT.

6 Parameters

- ECTS: 18
- Hours of study in total: 540
- Weekly hours per semester:
  - Contact hours: 0
  - Self-Study hours: 540
- Course characteristics: compulsory
- Course frequency: every year – winter semester
- Maximal capacity: individual participation
- Course admittance prerequisites:

	• Skills trained in this course: • Assessment of the course: Project thesis about own research in an ongoing project as individual homework + presentation in colloquium (100%) • Teaching staff: all professors
7	**Learning outcomes** 7.1 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 7.2 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 7.3 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)
8	**Teaching and training 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 • E-learning course on scientific work and scientific writing • Individual review and feedback on papers and presentations
9	**Course mapping** Input for: P – Master Thesis + Colloquium Input from: none
10	**References** According to topic

Master Thesis + Colloquium

Code Number	Workload	Credits	Semester	Frequency	Duration
	900 h	30	4	summer semester	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	Master Thesis	0 h (individual consulting and colloquium)	900 h	individual participation

2 Course Description

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.

3 Course Structure

Students will select a topic from one of the ongoing projects or an industry case in Digitalisation, Software Engineering and Digital Systems. The 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).

4 Application Focus

The Master thesis is done in connection with a research project. It is recommended to do the project and the thesis in connection with an internship/student job in industry or within a research project at a university or research institute, e.g. IDiAL.

5 Scientific Focus

The Master thesis is embedded into the scientific activities of the university, especially within the research institutes IDiAL and IKT.

6 Parameters

- ECTS: 30
- Hours of study in total: 900
- Weekly hours per semester: only colloquium
  - Contact hours: 0 (individual consulting and colloquium)
  - Self-Study hours: 900
- Course characteristics: compulsory
- Course frequency: every year – summer semester
- Maximal capacity: individual participation
- Course admittance prerequisites: only one module from semester 1 – 3 open
- Skills trained in this course:

	• Assessment of the course: Master thesis about own research in an ongoing project as individual homework + presentation in colloquium (100%) • Teaching staff: all professors
7	**Learning outcomes** 7.1 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 • Knows how to document new findings according to scientific standards 7.2 Skills • Can define and plan an own research project • Can apply appropriate research methodology • Can create own research findings • Can describe state of the art, methodology and findings in a scientific report 7.3 Competence – attitude • Can compare own findings with state of the art and do a critical discussion • Can run an own scientific research project and create new findings • Masters uncertainty and unknown topics in new area • Can present and defend results (in colloquium or at a conference)
8	**Teaching and training 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 • E-learning course on scientific work and scientific writing • Individual review and feedback on papers and presentations
9	**Course mapping** None – can be based on research project thesis
10	**References** According to topic

Attachment 2: Catalogue of Compulsory Elective Modules

Catalogue of Compulsory Module (Electives 1, 2 and 3)*						
Module	**module examin-ation**	**mod-nr/ exam-nr**	**student workload**			**ECTS-points**
			contact hours		**self-study (hrs)**	
			SWS[1]	**hours**		
Software Engineering Project	MOD-E01	48201	4	60	120	6
Requirements Engineering	MOD-E02	46910	4	60	120	6
Human Centered Digitalization***	MOD-E03	48202	4	60	120	6
Formal Methods	MOD-E04	48203	4	60	120	6
Digital Business Ecosystems***	MOD-E05	48204	4	60	120	6
Trends in Digital Transformation	MOD-E06	48205	4	60	120	6
Information Processing and Data Analytics	MOD-E07	48207	4	60	120	6
Managing Digital Change***	MOD-E08	48208	4	60	120	6
Smart Home & Smart Building & Smart City	MOD-E09	48209	4	60	120	6
IoT & Edge Computing	MOD-E10	48210	4	60	120	6
Research Seminar	S	48206	4	60	120	6
Module(s) from cooperating institutions						
Module(s) from study courses of the home institution**						

* From the Catalogue of Compulsory Electives a minimum of 3 modules must be completed with an examination (MOD2-05, MOD3-01 and MOD3-02). More than 18 credit points may be obtained which will be marked in the certificate.

** If compulsory elective modules of the Ruhr Master School (RMS) are part of the course programmes of Dortmund University of Applied Sciences and Arts (Fachhochschule Dortmund), students must complete the examinations within their own course programme.

*** At least one of the modules (MOD-E03, MOD-E05, or MOD-E08) must be takes as Elective.

Upon application, modules of the course programmes participating in the RMS may be elected.

Compulsory Elective

Software Engineering Project (MOD-E01)

Code Number	Workload	Credits	Semester	Frequency	Duration
48201	180 h	6	3	winter semester	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	Software Engineering Project	4 SWS / 60 h	120 h	25 students

2 Course Description

The aim of this course is to provide students with theoretical and practical experience in software engineering. Therefore, the students work in teams on real world tasks in cooperation with industry partners. The course focuses on software architecture and software engineering principles that are the foundation for implementing software systems. During the course, the students need to apply agile methods to their project and team for a dynamic software engineering approach. Evaluating software tools for their project is another task within this course, e.g. continuous delivery, IDEs. In summary, the students implement the complete life cycle from requirements engineering to design over the development of a software system.

3 Course Structure

The course is training software engineering skills by applying the following competences (from previous modules) within a realistic project (e.g. industry case):

- Object oriented modeling and design
- Architecture Design (Patterns, Frameworks, Libraries)
- Software Testing
- Tools
  - Version control systems (Git, SVN, Mercurial SCM)
  - Code management
  - Ticket systems and bug tracker
  - (Continuous) integration and release management
  - Documentation
- Processes
  - Classical software development
  - Agile software development (Scrum)
- Requirements Engineering
- Project management, project planning, quality management

4 Application Focus

Within a block-week, the students realize a whole software project starting from requirements engineering to design and development. The whole process is accompanied by an industry partner and takes place in the User Innovation Center.

5 Scientific Focus

	• Scientific documentation of the content used in the project as well as the related and applied principles • Consideration of scientific sources/papers from the Requirements Engineering and Software Engineering • The documentation of a scientific nature is also an assessment basis for the overall grade of this course
6	**Parameters** • ECTS: 6 • Hours of study in total: 180 • Weekly hours per semester: 4 – Contact hours: 60 – Self-Study hours: 120 • Course characteristics: elective • Course frequency: every year - winter semester • Maximal capacity: 25 students • Course admittance prerequisites: MOD1-01 Innovation Driven Software Engineering, MOD1-02 Software Architectures, MOD1-04 R&D Project Management • Skills trained in this course: theoretical knowledge, practical skills and scientific competences • Assessment of the course: Practical Skills (50%): realizing a real-world project within the User Innovation Center during a block week and Scientific Competences (50%): written paper (literature review, reflection of project with current research, approx. 25 pages) and presentation (in class or at a student conference, e.g. International Research Conference Dortmund) • • Teaching staff: Prof. Dr. Sabine Sachweh, external lecturers from industry and/or partner universities, PhD students from IDiAL
7	**Learning outcomes** 7.1 Knowledge • Students know modeling tools for software design • Students know concepts and processes for agile software development • Students know how to create test suites for automated software testing • Students know how to use typically used tools in the software engineering process 7.2 Skills • Students can apply processes and methods to specific project needs • Students can evaluate and use tools for developing software systems in a team • Students can use tools to support the development process in a team • Students can use tools to improve software quality 7.3 Competence – attitude • Can discuss and defend results in topics related to the lecture content • Can work in a team on scientific topics • Can understand lecture related content and translates between different domains
8	**Teaching and training methods** • Theoretical knowledge: lectures on requirements engineering • Practical Skills: requirements analysis of a project with DOORS, group work to train concepts and methods, to develop skills and to work on case studies

	• Scientific Competences: research paper on literature review about RE topic
9	**Course mapping** Input for: none Input from: MOD1-01 Innovation Driven Software Engineering MOD1-02 Software Architectures MOD1-04 R&D Project Management MOD2-02 Software-intensive Solutions
10	**References** <u>Basics & Practitioner</u> Ian Sommerville, Software Engineering, Global Edition, 10th Edition, Pearson, 2015 Hans van Vliet, Software Engineering: Principles and Practice, 3rd Edition, Woley, 2008 Eric Evan, Domain Driven Design, Addison Wesley, 2003 Vaughn Vernon, Domain-Driven Design Distilled, Addison-Wesley Professional, 2016 Erich Gamma, Richard Helm, Ralph E. Johnson, John Vlissides, Design Patterns. Elements of Reusable Object-Oriented Software, Prentice Hall, 1994 Erich Gamma, Ralph Johnson, John M. Vlissides, Richard Helm, Martin Fowler, Design Patterns: Elements of Reusable Object Oriented Software, 2nd Edition, Pearson Education, 2020

Compulsory Elective

Requirements Engineering (MOD-E02)

Code Number	Workload	Credits	Semester	Frequency	Duration
46910	180 h	6	3	winter semester	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	Requirements Engineering	4 SWS / 60 h	120 h	25 students

2 Course Description

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 design flow. Requirements are the starting point and main angle for design, verification & validation, and for the test and integration of systems. 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 – especially for large and complex mechatronic systems. In this module, students will get specific knowledge about the state of the art and the main future challenges in RE.

3 Course Structure

1. Introduction (What is a requirement?, problem vs. solution)
2. Frameworks (e.g. Jackson's WRSPM Modell)
3. Requirements Engineering Process (stakeholder, activities)
4. System and system context
5. Elicitation of requirements (techniques and supporting activities, Kano model)
6. Textual requirements documents
7. Requirements modeling (e.g. goal-oriented modeling, requirements patterns)
8. Non-functional requirements
9. Validation of requirements
10. Requirements Management (attributes, prioritization, traceability, change management, RE tools, CMMI, ReqIF exchange format)
11. Software product lines and variability management

4 Application Focus

Requirements analysis of an industrial case with DOORS

5 Scientific Focus

Paper with literature review/state-of-the-art in RE

6 Parameters

- ECTS: 6
- Hours of study in total: 180
- Weekly hours per semester: 4
  - Contact hours: 60
  - Self-Study hours: 120
- Course characteristics: elective
- Course frequency: every year - winter semester

	• Maximal capacity: 25 students • Course admittance prerequisites: none • Skills trained in this course: theoretical knowledge, practical skills and scientific competences • Assessment of the course: Theoretical knowledge: Oral Exam at the end of the course (30%), Practical Skills: Individual programming task (40%): DOORS demonstration and presentation of example and Scientific Competences: Paper/essay on literature review about recent research as individual homework (30%) • Teaching staff: Prof. Dr. Erik Kamsties, PhD students from IDiAL
7	**Learning outcomes** 7.1 Knowledge • Knows frameworks and models for RE • Knows relevant RE processes and interfaces to other processes • Knows concepts and recent research on product line and variability management 7.2 Skills • Can model requirements with RE tools • Can set up and integrate RE tools into tool chains and design flows • Can derive requirements in a structured and comprehensive way 7.3 Competence – attitude • Understands the importance of RE in the early project phase • Can set up and lead RE in a cross domain team
8	**Teaching and training methods** • Theoretical knowledge: lectures on requirements engineering • Practical Skills: requirements analysis of a project with DOORS, group work to train concepts and methods, to develop skills and to work on case studies • Scientific Competences: research paper on literature review about RE topic
9	**Course mapping** Input for: none Input from: R&D Project Management (MOD1-04)
10	**References** <u>Basics & Practitioner</u> Pohl, K.; Requirements Engineering: Fundamentals, Principles, and Techniques, Springer 2010. Robertson, S. and Robertson, J.; Mastering the Requirements Process: Getting Requirements Right, Addison-Wesley, 2012 van Lamsweerde, A.; Requirements Engineering: From System Goals to UML Models to Software Specifications, John Wiley & Sons, 2009 Dick, J.; Hull, E.;Jackson, K.; Requirements Engineering 4th Edition, Springer, 2017. Ramachandran, M.; Zaigham, M.; Requirements Engineering for Service and Cloud Computing, Springer, 2017

	Laplante, P. A.; Requirements Engineering for Software and Systems (Applied Software Engineering Series), 3rd Edition, Auerbach Publications, 2017 Research (Conferences, Journals & selected articles) • ACM SIGSOFT • International Workshop on Requirements Engineering and Testing, at ICSE International Conference on Software Engineering, IEEE Press • IEEE International Requirements Engineering Conference (RE), e.g. 2019 Jeju Island, South Korea • IEEE Transactions on Software Engineering • IEEE Systems Journal Peterson Rodrigues, Miguel Ecar, Stefane V. Menezes, João Pablo S. da Silva, Gilleanes T. A. Guedes, and Elder M. Rodrigues. 2018. Empirical Evaluation of Formal Method for Requirements Specification in Agile Approaches. In Proceedings of the XIV Brazilian Symposium on Information Systems (SBSI'18). Association for Computing Machinery, New York, NY, USA Jarbele C. S. Coutinho, Wilkerson L. Andrade, and Patrícia D. L. Machado. 2019. Requirements Engineering and Software Testing in Agile Methodologies: a Systematic Mapping. In Proceedings of the XXXIII Brazilian Symposium on Software Engineering (SBES 2019). Association for Computing Machinery, New York, NY, USA Danyllo Albuquerque, Everton Guimaraes, Mirko Perkusich, Alexandre Costa, Emanuel Dantas, Felipe Ramos, and Hyggo Almeida. 2020. Defining agile requirements change management: a mapping study. In Proceedings of the 35th Annual ACM Symposium on Applied Computing (SAC '20). Association for Computing Machinery, New York, NY, USA

Compulsory Elective

Human Centered Digitalization (MOD-E03)

Code Number	Workload	Credits	Semester	Frequency	Duration
48202	180 h	6	3	winter semester	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	Human Centered Digitalization	4 SWS / 60 h	120 h	25 students

2 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.

3 Course Structure

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

4 Application Focus

Case Studies "Disruptive Changes by Information Technology"

Involvement in projects: Analyzing impacts and potentials for news products and services

5 Scientific Focus

(Pre-)Studies & surveys about socioeconomic impacts of digitalization

Paper with literature review/state-of-the-art

6 Parameters

- ECTS: 6
- Hours of study in total: 180
- Weekly hours per semester: 4
  - Contact hours: 60
  - Self-Study hours: 120
- Course characteristics: elective
- Course frequency: every year - winter semester
- Maximal capacity: 25 students

	• Course admittance prerequisites: Innovation Driven Software Engineering (MOD1-01), R&D Project Management (MOD1-04) • Skills trained in this course: theoretical knowledge, practical skills and scientific competences • 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) • Teaching staff: Prof. Dr. Christian Reimann, International experts from industry and academia, PhD students from IDiAL
7	**Learning outcomes** 7.1 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 7.2 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 7.3 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
8	**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
9	**Course mapping** Input for: R&D project & Thesis Input from: Innovation Driven Software Engineering (MOD1-01) R&D Project Management (MOD1-04) Usability Engineering (MOD2-01)
10	**References** <u>Basics</u> Luciano Floridi, The Logic of Information: A Theory of Philosophy as Conceptual Design, Oxford University Press, 2019

Luciano Floridi, The Ethics of Information, Oxford University Press, 2015

John Weckert (Editor), Computer Ethics, Routledge, 2019

Charles Ess, Digital Media Ethics 3rd Edition, Polity, 2020

Simon Winter, Human values in a digital society. ACM XRDS 25, 1, Fall 2018

(announced) P. G. Kirchschläger, Digital Transformation and Ethics: Ethical Considerations on the Robotization and Automatization of Society and Economy and the Use of Artificial Intelligence. Germany: Nomos, 2021

Practitioner

eHealth: Legal, Ethical and Governance Challenges, Carlisle George, Diane Whitehouse, Penny Duquenoy, Springer Science & Business Media, 2012

An Ethical Global Information Society: Culture and democracy revisited
IFIP Advances in Information and Communication Technology, Jacques J. Berleur, Diane Whitehouse, Springer, 2013

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

B. Bhushan et al. (Editors), Impact of Digital Transformation on Security Policies and Standards, Information Science Reference, 2019

ACM Code of Ethics, https://www.acm.org/code-of-ethics

IEEE Code of Ethics, https://www.ieee.org/about/corporate/governance/p7-8.html

IEEE Code of Conduct,
https://www.ieee.org/content/dam/ieee-org/ieee/web/org/about/ieee_code_of_conduct.pdf

Research (Conferences, Journals and selected papers):

- ACM Special Interest Group on Computers and Society (SIGCAS): https://dl.acm.org/sig/sigcas
- ACM SGICAS Conference on Computing and Sustainable Societies (COMPASS)
- C&T'19, 9th International Conference on Communities & Technologies – Transforming Communities, Vienna 2019
- Kalpana Shankar, Future proofing the digital society: an introduction to digital curation and data practices. SIGCAS Comput. Soc. 46, 1, March 2016
- Åke Grönlund, Participating in the Digital Society. Digit. Gov.: Res. Pract. 1, 2, Article 17, April 2020

Wail El Hilali and Abdellah El Manouar, Towards a sustainable world through a SMART digital transformation. In Proceedings of the 2nd International Conference on Networking, Information Systems & Security, NISS19, 2019

Dongwook Kim, Hun-Yeong Kwon, Daesung Jun, Eunmi Lee, Loni Hagen, and Soon Ae Chun, Opportunities and challenges in the intelligent society: smart cities, digital inclusion, and cybersecurity. In Proceedings of the 19th Annual International Conference on Digital Government Research: Governance in the Data Age (dg.o '18), 2018

P. G. Kirchschläger, Digital transformation of society and economy - ethical considerations from a human rights perspective. International Journal of Human Rights and Constitutional Studies, 6 (4), 301–321, 2019

	P. G. Kirchschläger, Homo Dignitatis – Ethical Orientation for Digital Transformation. Psychologie in Österreich, 4 (39), 274–284, 2019

Compulsory Elective

Formal Methods (MOD-E04)

Code Number	Workload	Credits	Semester	Frequency	Duration
48203	180 h	6	3	summer semester	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	Formal Methods	4 SWS / 60 h	120 h	25 students

2 Course Description

Software has become the driving force in the development of self-optimizing systems. Such systems include hard-realtime coordination, which is realized by software, at the network level between distributed components as well as controllers which are more and more implemented by software. The communication goes beyond the use of system and environmental data from controllers. If necessary, complex status information about appropriate protocols and communication channels are exchanged, which themselves can massively influence the underlying behavior of the individual components. This development leads to extremely complex hybrid (discrete / continuous) software. In addition, self-optimizing systems are often used in safety-critical environments. This enforces the use of formal verification techniques to ensure the correctness of specified properties.

In the course concepts and methods for the modelling and verification of these systems are introduced and formally described. In order to enable an efficient verification for such systems, techniques like abstraction, decomposition as well as rule-based modelling are introduced. Here, these non-orthogonal techniques are skillfully combined. One aim is to handle all models specified by all different domains. The presented approach for the model-based verification of systems is massively characterized by the integration of efficient verification techniques for the different domains, based on their domain specific model-based knowledge

3 Course Structure

- Motivation:
  - What are Formal Methods?
  - Why should we use Formal Methods?
  - When in the overall development process should we use Formal Methods?
- Model Checking
- Theorem Proving
- Testing
- SafeWare – Safety and Security in CPS
- Recent Research: literature review
- AMALTHEA Methodology and Tool Chain

4 Application Focus

Cyber-Physical-Systems, Cyber-Physical-Production-Systems

	AMALTHEA tool chain – will be used to integrate formal verification tools
5	**Scientific Focus** Paper with literature review/state-of-the-art in formal verification

6	**Parameters**
	
	• ECTS: 6
	• Hours of study in total: 180
	• Weekly hours per semester: 4
	  – Contact hours: 60
	  – Self-Study hours: 120
	• Course characteristics: elective
	• Course frequency: every year - winter semester
	• Maximal capacity: 25 students
	• Course admittance prerequisites: none
	• Skills trained in this course: theoretical knowledge and scientific competences
	• Assessment of the course: Oral Exam at the end of the course (50%) and individual research paper and presentation (50%)
	• Teaching staff: Prof. Dr. Martin Hirsch

7	**Learning outcomes** 7.1 Knowledge • Knows methodology of formal verification • Knows relevant theoretical background • Knows specific requirements 7.2 Skills • Can methods on use case • Can model verification artefacts (e.g. properties) • Can use MechatronicUML approach and tools 7.3 Competence – attitude • Can research on state of the art and theoretical background • Can demonstrate and discuss results in group • Can structure scientific field and get overview
8	**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
9	**Course mapping** Input for: None Input from: None
10	**References** <u>Basics</u> E. Clarke, Model Checking, MIT Press, 2000

	J. Bengtsson, W. Yi: Timed Automata: Semantics, Algorithms and Tools. In Lecture Notes on Concurrency and Petri Nets. W. Reisig and G. Rozenberg (eds.), LNCS 3098, Springer-Verlag, 2004 Tanenbaum, Andrew; van Steen, Marteen, Distributed Systems, 3rd Edition, 2017. Marvedel, Peter, Embedded System Design: Embedded Systems Foundations of Cyber-Physical Systems and the Internet of Things, Springer, 2017. Chris Hobbs, Embedded Software Development for Safety-Critical Systems, Second Edition, Routledge, 2019 Practitioner Spivey: The Z Reference Manual (http://spivey.oriel.ox.ac.uk/mike/zrm/zrm.pdf) T. Fischer, J. Niere, L. Torunski, and A. Zündorf: Story Diagrams: A new Graph Rewrite Language based on the Unified Modeling Language. In Proc. of the 6th International Workshop on Theory and Application of Graph Transformation (TAGT), Paderborn, Germany, 1998 T. Eckart, C. Heinzemann, S. Henkler, M. Hirsch, C. Priesterjahn, W. Schäfer: Modeling and verifying dynamic communication structures based on graph transformations. Computer Science - Research and Development 28(1): S. 3-22, Feb. 2013 Research (Conferences, Journals and selected papers): Safeware Engineering, https://www.safeware-engineering.org

Compulsory Elective

Digital Business Ecosystems (MOD-E05)

Code Number	Workload	Credits	Semester	Frequency	Duration
48204	180 h	6	2	summer semester	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	Digital Business Ecosystems	4 SWS / 60 h	120 h	25 students

2 Course Description

The term “Digital Business Ecosystem” (DBE) emerged beginning of the 2000s by adding “Digital” to Moore’s (1996) “Business Ecosystem” concept. The analysis, structuring, development and management of DBEs combine socio-economic concepts, ICT and biological concepts. Students will learn to understand, to analyse, to evaluate and to develop DBE for different application scenarios.

3 Course Structure

1. Cybernetics and systems view
1.1 Biological Systems
1.2 Cybernetics and Systems theory, social theories
1.3 System models, e.g. Ropohl, Systems engineering
1.4 Evolutionary and self-organizing systems

2. Socio-economic view
2.1 Business Ecosystems
2.2 Business processes, business models and value chains
2.3 Innovation, competition and dynamics in business ecosystems
2.3 Analysis of Case Studies

3. ICT view
3.1 Information supply chain
3.2 ICT architectures and tools for DBEs
3.3 Efficiency and effectivity for DBEs
3.4 Analysis of Case Studies

4 Application Focus

Students will be guided through a case study project where they set up a small DBE for an example case. They form teams and set up IT tools.

5 Scientific Focus

Students will do literature review on DBE and do scientific discussion and reflections

6 Parameters

- ECTS: 6
- Hours of study in total: 180
- Weekly hours per semester: 4

	– Contact hours: 60 – Self-Study hours: 120 • Course characteristics: elective • Course frequency: every year – summer semester • Maximal capacity: 25 students • Course admittance prerequisites: none • Skills trained in this course: theoretical knowledge, practical skills and scientific competencies • Assessment of the course: Theoretical knowledge: Oral or written exam at the end of the course (50%) and Practical Skills: contributions within case study project (team presentation) => demonstration of the result (50%) • Teaching staff: Prof. Dr. Carsten Wolff, guest lecturers from partner universities (e.g. FH Krems)
7	**Learning outcomes** 7.1 Knowledge Students can • explain the basics of cybernetics and systems theory • explain and compare digital business models • explain methods and tools for information supply chains • explain the core concepts of DBEs 7.2 Skills Students are able to • analyze and develop value chains and information supply chains • apply ICT tools for information supply chains • develop tailored processes for DBEs 7.3 Competence – attitude • Students train to develop and discuss concepts in teams • Students work in teams and set up DBE environments for their respective case study project
8	**Teaching and training methods** • Theoretical knowledge: Lectures introducing concepts, methods and tools • Practical Skills: Group work in the case study project to practice concepts and methods, to develop skills and to work on case studies • Scientific Competences: Presentations to communicate results and do a scientific discussion and reflection
9	**Course mapping** Input for: None Input from: None
10	**References**

	Basics F. Nashira, A. Nicolai, P. Dini, M.L. Louarn, L.R. Leon: Digital Business Ecosystem. European Commission, 2010, Retrieved from http://www.digital-ecosystems.org/book/de-book2007.html, , last accessed June 06, 2013 S. Sun, J. Yen: Information Supply Chain: A Unified Framework for Information-Sharing, P. Kantor et al. (Eds.): ISI 2005, LNCS 3495, pp. 422 – 428, 2005 CERP-IoT: Vision and Challenges for realizing the Internet of Things, European Union, 2010 A. Humphreys, K. Grayson: The Intersecting Roles of Consumer and Producer: A Critical Perspective on Co-Production, Co-Creation and Prosumption, Sociology Compass 2, 2008 Examples of selected papers Prince Kwame Senyo, Kecheng Liu, John Effah, Digital business ecosystem: Literature review and a framework for future research, International Journal of Information Management, Volume 47, August 2019, Elsevier Lenkenhoff, Kay, et al. "Key challenges of digital business ecosystem development and how to cope with them." Procedia CIRP 73 (2018): 167-172. Alghatam, Noora. "Public and Private Sector Collaboration to Establish Digital Business Ecosystems." Proceedings of the 20th Annual International Conference on Digital Government Research. 2019. Fuller, Jack, Michael G. Jacobides, and Martin Reeves. "The myths and realities of business ecosystems." MIT Sloan Management Review 60.3 (2019): 1-9.

Compulsory Elective

Trends in Digital Transformation (MOD-E06)

Code Number	Workload	Credits	Semester	Frequency	Duration
48205	180 h	6		annually	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	Trends in Digital Transformation	4 SWS / 60 h	120 h	25 students

2 Course Description

The module will introduce and discuss recent topics from scientific research and industrial R&D. The goal is to make students familiar with the trends and to encourage own scientific and practical work in the respective field. The module will use presentations by scientists and practitioners to introduce topics. Literature work including structured literature reviews and discussion of relevant research papers will further enhance the practical knowledge. Industry presentations and visits can deliver practical insights. The module can introduce several different areas or topics, or it can dive deep into one topic. This can involve own research work of students, e.g. in order to develop a research paper for a conference (preferably the Dortmund International Research Conference). The module can also include practical labs or experiments. Individual project work or group work in small project teams can be used to develop new results. Presentations can be used to discuss the results.

3 Course Structure

1. Introduction of a new trend in Digital Transformation
2. Literature research and discussion of the state of the art
3. (optional) company visit and /or discussion of practical cases
4. Industry presentations
5. Tool trainings and practical labs
6. Own research, e.g. with experiments or projects
7. Presentation of the results
8. Preparation of a paper for a conference

4 Application Focus

Discussion of industry cases

5 Scientific Focus

Scientific literature review, writing of a scientific paper, presentation at a conference

6 Parameters

- Course characteristics: elective
- Course frequency: every year – summer/winter semester
- Capacity: 25 students
- Course admittance prerequisites: none
- Skills trained in this course: theoretical, practical and methodological skills
- Assessment of the course: Oral Exam (30 min) at the end of the course (50%) and group work as homework (50%): research on a recent technology trend
- Teaching staff: depends on topic, (organizer: Prof. Dr. Carsten Wolff)

7	**Learning outcomes** 7.1 Knowledge • Knows recent trends in Digital Transformation • Knows the relevant scientific literature • Knows practical cases 7.2 Skills • Can do a structured literature review on a given topic • Can design own research on the topic • Can present research results 7.3 Competence - attitude • Can systematically explore a new scientific field • Can organize research work in an unknown field • Can synthesize and summarize findings in a meaningful way • Shows curiosity in scientific research
8	**Teaching and training methods** • Lecturers and industry presentations • Individual literature research • Assignments, e.g. writing of a paper
9	**Course mapping** Requires: • Scientific & Transversal Skills 1 (MOD1-05) Connects to: • Scientific & Transversal Skills 2 (MOD2-04) • Research Seminar • Research Project (Thesis) (MOD3-03) • Master Thesis and Colloquium
10	**References** <u>Specific for the recent research topic</u> For Example: • ACM Special Interest Group on Software Engineering (SIGSOFT) • ACM Special Interest Group on Computers and Society (SIGCAS) • ACM Special Interest Group on Mobility of Systems, Users, Data and Computing (SIGMOBILE) • ACM Special Interest Group on Computer Human Interaction (SIGCHI) • International Project Management Association, IPMA • IEEE Transactions on Software Engineering • IEEE Systems Journal • ACM SGICAS Conference on Computing and Sustainable Societies (COMPASS) • ACM/IEEE Symposium on Edge Computing (SEC) • IEEE Transactions on Human-Machine Systems <u>Publications IDiAL, FH Dortmund:</u> https://www.fh-dortmund.de/en/idial/forschung/veroeffentlichungen_statisch.php

Compulsory Elective

Information Processing and Data Analytics (MOD-E07)

Code Number	Workload	Credits	Semester	Frequency	Duration
48207	180 h	6	3	winter semester	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	Information Processing and Data Analytics	4 SWS / 60 h	120 h	25 students

2 Course Description

Modern management is based on facts and on data. Dealing with data, analyzing data and deriving conclusions and decisions from data is crucial for management. The module is developing the topics of information processing and data analytics along a case study.

3 Course Structure

1. Information processing and data collection
1.1 Development of indicator systems
1.2 Design of data collection experiments with online tools
1.3 IT tools for data collection
1.4 Advanced MS Excel

2. Data bases and data warehouses
2.1 Introduction to databases, SQL
2.2 Data warehouse systems
2.3 Cloud based systems
2.3 Analysis of Case Studies

3. Data analytics
3.1 Data refinement
3.2 Data analytics and business intelligence
3.3 Probabilistic methods
3.4 Artificial intelligence and learning (introduction to IBM Watson)

4 Application Focus

Students will be guided through a case study project where they set up a small experiment for data collection, data storage and query and data processing for an example case. They form teams and set up IT tools.

Trainings: students attend an Excel training and an IBM Watson training

5 Scientific Focus

Students work in teams and set up data analytics experiments and tools for their respective case study project.

6 Parameters

- ECTS: 6

	• Hours of study in total: 180
	• Weekly hours per semester: 4
	  – Contact hours: 60
	  – Self-Study hours: 120
	• Course characteristics: elective
	• Course frequency: every year - winter semester
	• Maximal capacity: 25 students
	• Course admittance prerequisites: none
	• Skills trained in this course: theoretical knowledge, practical skills and scientific competences
	• Assessment of the course: Theoretical knowledge (30%): Written or oral Exam at the end of the course, Practical Skills (50%): contributions within case study project (team presentation) and Scientific Competences (20%): written paper (report, approx. 10 pages) and presentation (in class or at a student conference, e.g. International Research Conference Dortmund)
	• Teaching staff: Prof. Dr. Christian Reimann, PhD students from IDiAL, guest lecturers from partner universities (e.g.. FH Krems)

7	**Learning outcomes** 7.1 Knowledge Student can • explain the basic characteristics of data and data collection • explain advanced functionality of Excel • explain database and data warehouse concepts • explain the core concepts of data analytics and business intelligence 7.2 Skills • develop data collection experiments with online tools • apply MS Excel for data analytics • set up and use simple SQL databases • set up and use tools for statistical data analysis • use IBM Watson for AI experiments 7.3 Competence – attitude • students train to do surveys with people from different cultural backgrounds • in discussion students develop a critical attitude to data based decision making and to issues like privacy and data protection
8	**Teaching and training methods** • Theoretical knowledge: (video-)lectures introducing concepts, methods and tools, tool tutorials • Practical Skills: group work in the case study project to practice concepts and methods, to develop skills and to work on case studies • Scientific Competences: presentations to communicate results and do a scientific discussion and reflection
9	**Course mapping** Input for: none Input from: none

10	**References** Basics & Practitioner Ralph Kimball, Margy Ross, Warren Thornthwaite, Joy Mundy, Bob Becker: The Kimball Group Reader: Relentlessly Practical Tools for Data Warehousing and Business Intelligence, John Wiley & Sons 2010 Steven S. Skiena, The Data Science Design Manual (Texts in Computer Science), Springer 2017 Galit Shmueli, Peter C. Bruce, Inbal Yahav, Nitin R. Patel, Kenneth C. Lichtendahl, Data Mining for Business Analytics: Concepts, Techniques, and Applications in R, Wiley & Sons, 2017 Thomas A. Runkler, Data Analytics: Models and Algorithms for Intelligent Data Analysis, 3rd Edition, Springer Vieweg, 2020 Alan Beaulieu, Learning SQL: Generate, Manipulate, and Retrieve Data, O'Reilly, 2020 John D. Kelleher and Brendan Tierney, Data Science. The MIT Press, 2018 Alan Said and Vicen Torra, Data Science in Practice (1st. ed.). Springer Publishing Company, Incorporated, 2018 Research (Journals, Conferences and selected papers) ACM Special Interest Group on Management of Data (SIGMOD) SIGMOD '19: Proceedings of the 2019 International Conference on Management of Data Lise Getoor, Responsible Data Science. In Proceedings of the 2019 International Conference on Management of Data (SIGMOD '19), 2019 Longbing Cao, Data Science: A Comprehensive Overview. ACM Comput. Surv. 50, 3, Article 43 (October 2017), 2017

Compulsory Elective

Managing Digital Change (MOD-E08)

Code Number	Workload	Credits	Semester	Frequency	Duration
48208	180 h	6	2	summer semester	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	Managing Digital Change	4 SWS / 60 h	120 h	25 students

2 Course Description

The digital transformation is to a relevant extent a change process with a huge impact on organizations, processes, business model, the socio-economic environment and finally the affected hum beings. Managing the digital change means doing change management in a very specific context by implementing change projects. The module intends to give students a scientific insight into the relevant underlying mechanisms of the digital change process.

3 Course Structure

1. Digital Transformation in Organisations
1.1 New digitalized forms of organisation
1.2 Business models and business relations in the digital era
1.3 Structural resistance of organisations against digital change
1.4 Chances and risks of digital transformation in organisations

2. Socio-economic Impact of Digital Transformation
2.1 Digital transformation as a socio-economic trend
2.2 “Arbeit 4.0”
2.3 Education and training as impact mitigation
2.3 Analysis of Case Studies

3. Sustainable Digital Transformation
3.1 Stakeholder management in digital transformation projects
3.2 Project management for digital transformation projects
3.3 Efficiency and effectivity measurement
3.4 Sustainability and maturity models

4 Application Focus

Students will be guided through a case study project where they plan a digital transformation project for an example case. This example case will be taken preferably from a real company project. Companies can bring their digital transformation projects as a case study for a block week or summer school workshop. Students form teams to prepare the respective project and present it in a kick-off presentation to the companies.

5 Scientific Focus

Literature review and analysis. Deductive own research based on the literature. Scientific reflection and discussion in the teams.

6	**Parameters**
	• ECTS: 6
	• Hours of study in total: 180
	• Weekly hours per semester: 4
	  – Contact hours: 60
	  – Self-Study hours: 120
	• Course characteristics: elective
	• Course frequency: every year - summer semester
	• Maximal capacity: 25 students
	• Course admittance prerequisites: none
	• Skills trained in this course: theoretical, practical and scientific skills and competences
	• Assessment of the course: contributions within case study project (team presentation) (50%) and written paper (literature review, report or survey, approx. 25 pages) and presentation (in class or at a student conference, e.g. International Research Conference Dortmund) (50%)
	• Teaching staff: Prof. Dr. Carsten Wolff, guest lecturers from partner universities, EuroMPM

7	**Learning outcomes** 6.1 Knowledge • explain the basics of the digital transformation in organizations • explain and compare digital business models • explain methods and tools for change management • explain the core concepts of “Arbeit 4.0” 6.2 Skills • analyze and develop digital transformation projects • apply change management to organizations • develop tailored concepts for sustainable digital transformation 6.3 Competence - attitude • Students train to develop and discuss concepts in teams • They can present their results to companies and discuss in a professional context • Students work in teams and set up a digital transformation project for their respective case study
8	**Teaching and training methods** • lectures introducing concepts, methods and tools, own literature reading • group work in the case study project to practice concepts and methods, to develop skills and to work on case studies • presentations to communicate results and do a scientific discussion and reflection
9	**Course mapping** Input for: None Input from: None

10	**References**

Csedo, Z., Kovacs, K. & Zavarko, M. (2017): How does Digitalization Affect Change Management: Empirical Research at an Innovative Industrial Group. European Journal of Business and Management. 9 (36), 1-5

Ehrhart, M., Schneider, B. & Macey, W. (2013): Organizational Climate and Culture an Introduction to Theory, Research, and Practice. New York, Routledge

Raskino, M.; Waller, G. (2016): Digital to the Core: Remastering Leadership for Your Industry, Your Enterprise, and Yourself, Routledge

Rogers, D.L. (2016): The Digital Transformation Playbook - Rethink Your Business for the Digital Age, Columbia Business School Publishing

Compulsory Elective

Smart Home & Smart Building & Smart City (MOD-E09)

Code Number	Workload	Credits	Semester	Frequency	Duration
48209	180 h	6	2	summer semester	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	Smart Home & Smart Building & Smart City	4 SWS / 60 h	120 h	25 students

2 Course Description

The digital transformation is a major driver for the change in people's living environment. It affects the technical design of infrastructure systems, starting from people's home via larger buildings and reaching up to systems like cities or districts. It covers home automation, energy and mobility systems and assistance systems. The course introduces the trends, developments and standards from the smart home, smart building and smart city domains and put them into the context of software and IoT systems. The aim is to enable students to develop larger software systems within the given context and to integrate them with other IoT and cloud systems. Therefore, it is intended to form a domain specific view on the digital transformation.

3 Course Structure

1. Smart home
1.1 Home automation
1.2 Standards and bus systems (e.g. KNX)
1.3 Energy and mobility in smart home systems
1.4 Ambient Assisted Living

2. Smart Building
2.1 Building Information Systems (BIM)
2.2 Safety and Security in Smart Buildings
2.3 Facility Management and Smart Building

3. Smart City
3.1 Smart City concepts and relevant trends
3.2 Integration of Logistics, Energy, Supplies and Mobility
3.3 Stakeholder and Citizen Involvement
3.4 Case Study: Smart City Alliance Dortmund

4 Application Focus

Project Smart Systems: students will set up and implement an example or a part of a Smart System (Home, Building, City). The respective case study will be taken from a recent R&D project or an industry case. The result will be a demonstrator system.

5 Scientific Focus

Students will do a scientific evaluation of the potential of Smart Systems usage in a specific domain (e.g. transportation) based on recent scientific literature. It is intended to take issues from the Smart City Alliance Dortmund or from ruhrvalley.

6	**Parameters**
	• ECTS: 6
	• Hours of study in total: 180
	• Weekly hours per semester: 4
	  – Contact hours: 60
	  – Self-Study hours: 120
	• Course characteristics: elective
	• Course frequency: every year - summer semester
	• Maximal capacity: 25 students
	• Course admittance prerequisites: none
	• Skills trained in this course: theoretical, practical and scientific skills and competences
	• Assessment of the course: Written Exam at the end of the course (50%) and Individual programming task (50%): implementation of Smart System (or parts of it), demonstration of the results
	• Teaching staff: Prof. Dr. Ingo Kunold, staff from IKT institute, guest lecturers from joint research projects

7	**Learning outcomes** 7.1 Knowledge • Knows relevant home automation systems and standards • Know smart building concepts (e.g. BIM) • Knows relevant trends and projects in Smart City • Is aware of critical limitations, esp. safety and security issues 7.2 Skills • Can design concepts for smart home/smart building/smart city systems • Can implement IoT, Cloud and SW components into such systems • Can apply state of the art tools and systems (e.g. KNX) • Can select IoT and cloud platforms according to smart home/building/city requirements 7.3 Competence – attitude • Can discuss smart home/building/city systems with experts • Can lead cross domain design in this domain • Can contribute within the Dortmund Smart City Alliance
8	**Teaching and training methods** • Theoretical knowledge: e-learning modules on Smart Systems, tool tutorials • Practical Skills: Projects, Labs & Exercises, small project with Smart Systems • Scientific Competences: own research on Smart Systems
9	**Course mapping** Input for: None Input from: MOD1-02 Software Architectures MOD1-03 Digital Systems 1 MOD2-02 Software-intensive Solutions MOD2-03 Digital Systems 2
10	**References** to be defined

Compulsory Elective

IoT & Edge Computing (MOD-E10)

Code Number	Workload	Credits	Semester	Frequency	Duration
48210	180 h	6	2	summer semester	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	IoT & Edge Computing	4 SWS / 60 h	120 h	25 students

2 Course Description

Internet of things (IoT) is a fundamental building block for digitization and the upcoming information society. This course provides insights into key IoT-technologies including embedded systems, networks and cloud computing. For the selection of use cases and technologies the course focuses on the area of Edge Computing. Within this area students learn about latency analysis and optimization in distributed systems. Last not least, the course offers hands on experiences with IoT and Edge Computing technologies through focused team projects and homework assignments.

3 Course Structure

1. Introduction
2. Real-time Embedded Systems
3. Real-Time Networking
4. Cloud Computing
5. Edge Computing

4 Application Focus

Students conduct a project about Edge Sensor Fusion

Students work with Gabriel - Edge Computing Platform for Wearable Cognitive Assistance

5 Scientific Focus

During the module recent topics from the Open Edge Computing Initiative will be discussed and papers from relevant conferences will be reviewed.

6 Parameters

- ECTS: 6
- Hours of study in total: 180
- Weekly hours per semester: 4
  - Contact hours: 60
  - Self-Study hours: 120
- Course characteristics: elective
- Course frequency: every year - summer semester
- Maximal capacity: 25 students

	• Course admittance prerequisites: • Skills trained in this course: theoretical, practical and scientific skills and competences • Assessment of the course: Oral Exam at the end of the course (50%) and individual programming task (50%): implementation of cloud based IoT system for a robot, demonstration of the result • Teaching staff: Prof. Dr. Rolf Schuster
7	**Learning outcomes** 6.1 Knowledge • Knows concepts and architectures of real-time embedded systems • Knows key aspects of real-time networking • Has acquired overview of cloud computing and selected cloud platforms 6.2 Skills • Can implement, deploy and test simple IoT-systems • Can set-up and utilize a cloud system • Can analyze the E2E latency in distributed systems 6.3 Competence - attitude • Can design an simple IoT system for a given set of requirements • Can structure an IoT development project regarding function and time • Can propose and implement measures to reduce latency in a distributed system
8	**Teaching and training methods** • E-learning modules and lectures on IoT and Edge Computing • Small project with Eclipse IoT stack • Access to the Open Edge Computing Initiative and the Living Edge Labs
9	**Course mapping** Input for: None Input from: None
10	**References** <u>Basics & Practitioner</u> Peter Marwedel: Embedded System Design, 2nd Edition, Springer, 2011 Thomas Erl, Zaigham Mahmood, Ricardo Puttini, Cloud Computing, Prentice Hall, 2013 Dimitrios Serpanos, Marilyn Wolf, Internet-of-Things (IoT) Systems: Architectures, Algorithms, Methodologies, Springer, 2018 Arthur M. Langer, Analysis and Design of Next-Generation Software Architectures: 5G, IoT, Blockchain, and Quantum Computing, Springer, 2020 Giacomo Veneri, Antonio Capasso, Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0, Packt Publishing, 2018 Perry Lea, IoT and Edge Computing for Architects: Implementing edge and IoT systems from sensors to clouds with communication systems, analytics, and security, 2nd Edition, Packt Publishing, 2020

	Fadi Al-Turjman (Editor), Edge Computing: From Hype to Reality, Springer 2018 S. Balamurugan, Principles of Fog and Edge Computing: With Applications and Case Studies, Scholars' Press, 2018 Research (Conferences, Journals & selected papers) • ACM SIGMOBILE • SEC, ACM/IEEE Symposium on Edge Computing, e.g. SEC '19: Proceedings of the 4th ACM/IEEE Symposium on Edge Computing, Arlington Virginia, 2019 • IEEE International Conference on Edge Computing (EDGE), e.g. EDGE2019 Milan Italy Satyanarayanan, M., Gao, W., Lucia, B., The Computing Landscape of the 21st Century, Proceedings of the 20th International Workshop on Mobile Computing Systems and Applications (HotMobile '19), Santa Cruz, CA, February 2019 Satyanarayanan, M., How we created edge computing, Nature Electronics, 2(1), January 2019 Maurantonio Caprolu, Roberto Di Pietro, Flavio Lombardi, Simone Raponi; Edge Computing Perspectives: Architectures, Technologies, and Open Security Issues. Published in: 2019 IEEE International Conference on Edge Computing (EDGE), Milan Italy

Compulsory Elective

Research Seminar (S)

Code Number	Workload	Credits	Semester	Frequency	Duration
48206	180 h	6	2 + 3	summer and winter semester	1 Semester

1	Course Title	Contact hours	Self-Study	Planned Group Size
	Research Seminar	4 SWS / 60 h	120 h	individual

2 Course Description

The Research Seminar is intended to introduce students into scientific writing, literature review and into discussion of research questions in a scientific auditory. Students will write a scientific report or essay on a recent research topic from one of the ongoing projects. The seminar will be a preparation for further work on the research project thesis and the master thesis. The intention of the seminar is to explore a certain scientific field and to formulate the scientific state of the art and the open research questions. A motivation for students will be the possibility to publish and present excellent papers at a small conference.

3 Course Structure

Students will select a topic from one of the ongoing projects in Digitalization, Software Engineering and Digital Systems. The student will get individual consulting and feedback. During the semester the students will write a paper/report and present it in a colloquium at the end of the semester.

The research seminar is recommended for students who want to follow a more scientific path within the Master's program. It lays foundations for the scientific quality of the later Research Project Thesis and Master Thesis. Excellent papers will be published and presented (oral or poster) at the Dortmund International Research Conference at FH Dortmund.

4 Application Focus

The research seminar has a mainly scientific focus.

5 Scientific Focus

The Research Seminar is embedded into the scientific activities of the university, especially within the research institutes IDiAL and IKT.

6 Parameters

- ECTS: 6
- Hours of study in total: 180
- Weekly hours per semester: 4
  - Contact hours: 60
  - Self-Study hours: 120
- Course characteristics: elective

	• Course frequency: summer and winter semester • Maximal capacity: individual • Course admittance prerequisites: none • Skills trained in this course: theoretical, practical and scientific skills and competences • Assessment of the course: Report as individual homework + presentation in colloquium (100%) • Teaching staff: all professors
7	**Learning outcomes** 7.1 Knowledge • Knows state of the art in a certain scientific field • Knows open research questions in this field • Knows relevant literature 7.2 Skills • Can analyze scientific literature based on a comprehensive review • Can write a paper/report according to scientific standards • Can synthesize findings in own words 7.3 Competence – attitude • Can run an own small scientific research project • Can present and defend results at a conference •
8	**Teaching and training methods** Research seminars are done with individual supervision: • Writing of a scientific report • Presentations to communicate and discuss the findings • Individual review and feedback on papers and presentations
9	**Course mapping** Input for: • MOD3-03 – Research Project (Thesis) + Colloquium • P – Master Thesis + Colloquium Input from: None
10	**References** <u>Research Methods</u> Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, Creswell, SAGE Publications, 5th Edition, 2018 Research Methods: A Tool for Life, Bernard C. Beins, Cambridge University Press, 4th Edition, 2018 <u>German and European Research Agendas, recent research papers</u> e.g. publications IDiAL, FH Dortmund: https://www.fh-dortmund.de/en/idial/forschung/veroeffentlichungen_statisch.php