

Software Systems Engineering

HPI-SSE-C: Conceptual Foundations (Software Systems Engineering)		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Mandatory module			
Module content and qualification goals:	<p><i>Content</i> Modern software systems are characterized by their increasing complexity. This module teaches basic scientific concepts, methods and techniques for modeling, designing and analyzing complex IT systems. The main goal is the application of conceptual and theoretical principles to concrete, practical questions. This includes methods for modeling complex software systems, made up of a large number of modules that often work in parallel. This module considers the basic characteristics of complex software systems, the components and data structures used, methods for designing a modern system architecture and methods for designing and analyzing specific algorithmic processes with regard to their scalability and efficiency.</p> <p><i>Qualification goals</i> Students acquire detailed knowledge of the subject matter covered in the module. Students ...</p> <ul style="list-style-type: none"> - can master the basic characteristics of modern software systems and can systematically investigate existing systems, - can select and apply suitable solution concepts and strategies for a given problem, - acquire experience in handling software systems and tools and modern <i>system architectures</i>, - acquire subject-specific theoretical, methodical and practical knowledge, - are able to independently develop and use suitable information sources to solve problems, - improve their learning skills, - gain insight into current solutions in industrial and research projects and into the current state of research. <p>Courses assigned to this module are offered in English.</p>			
Module (partial) examinations (number, form, scope):	Exam types: Written exam (90–120 mins.) Oral exam (30–45 mins.)			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in semester hours)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Lecture (lecture)	3	-	-	-
Exercise (exercise)	1	-	Exercise tasks (50%)	-
Offered:	WiSe			
Prerequisite for module participation:	None			
Department:	Digital Engineering (HPI)			

HPI-SSE-D: Data Foundations (Software Systems Engineering)		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Mandatory module			
Module content and qualification goals:	<p><i>Content</i></p> <p>An important feature of modern software systems is the inclusion of large amounts of heterogeneous data. Data-driven methods such as machine learning have made it possible to automate certain processes using software systems. For this reason, the data used and its processing, in many cases, largely determines the functionality and architecture of a software system. This module teaches basic techniques and concepts in the areas of data engineering, machine learning and data science as well as information systems. Students gain the ability to provide an assessment of various data-driven processes based on application-specific questions, depending on the type and scope of the corresponding data. This requires knowledge of the relevant methods and their essential characteristics such as scalability. The practical understanding of the methods during the lectures is deepened through exercises dealing with <i>empirical comparisons</i>.</p> <p><i>Qualification goals</i></p> <p>Students acquire detailed knowledge of the subject matter in the module.</p> <p>Students</p> <ul style="list-style-type: none"> - become familiar with various data-driven methods for the analysis and processing of huge and complex data collections, - can assess these methods in respect to their applicability and basic characteristics and compare them on an empirical level, - acquire experience in the use of specific software libraries and tools for handling heterogeneous data, - gain insights into the current solutions in industry and the current state of research. <p>Courses assigned to this module are offered in English.</p>			
Module (partial) examinations (number, form, scope):	<p>Exam types:</p> <p>Written exam (90–120 mins.)</p> <p>Oral exam (30–45 mins.)</p>			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in semester hours)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Lecture (lecture)	3	-	-	-
Exercise (exercise)	1	-	Exercise tasks (50%)	-
Offered:		WiSe		
Prerequisite for module participation:		None		
Department		Digital Engineering (HPI)		

HPI-SSE-A: Analytical Foundations (Software Systems Engineering)		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Mandatory module			
Module content and qualification goals:	<p><i>Content</i> Numerous methods used in modern software systems are based on mathematical analysis concepts. This is especially true when data analysis and machine learning are involved. In addition, such principles are indispensable for an in-depth analysis and evaluation of complex processes. This module provides knowledge of the use of mathematical and analytical methods on practical issues that arise in the analysis and development of software systems. The focus is on mathematical and statistical principles for data analysis and prediction. This includes regular practical exercises on how to apply such methods to real data from different application areas.</p> <p><i>Qualification goals</i> Students acquire detailed knowledge of the subject matter in the module. Students</p> <ul style="list-style-type: none"> - master foundational concepts from mathematics and statistics, which are relevant in modern software systems, - can select and apply suitable <i>solution concepts</i> and strategies for a given problem, - acquire experience in handling practical software libraries and tools for the mathematical analysis of data. <p>Courses assigned to this module are offered in English.</p>			
Module (partial) examinations (number, form, scope):	Exam types: Written exam (90–120 mins.) Oral exam (30–45 mins.)			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in semester hours)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Lecture (lecture)	3	-	-	-
Exercise (exercise)	1	-	Exercise tasks (50%)	-
Offered:	SoSe			
Prerequisite for module participation:	None			
Department:	Digital Engineering (HPI)			

HPI-SSE-S: Systems Foundations (Software Systems Engineering)		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Mandatory module			
Module content and qualification goals:	<p><i>Content</i> This module teaches practical concepts, methods and techniques for designing, analyzing, developing and maintaining complex IT systems. The focus is on the topics of system architecture, system modeling, scalability and distribution, implementation concepts and their classification in the state of the art. Software architectures for diverse computer systems are considered—from small mobile devices to large computer clusters or distributed infrastructures such as the Internet or a mobile radio system. The networking of various decentralized and sometimes parallel working components also plays a central role, since such a system architecture can require special implementation concepts and communication protocols during development. Among the decentralized approaches are cloud-based software systems.</p> <p><i>Qualification goals</i> Students acquire detailed knowledge of the subject matter in the module. Students</p> <ul style="list-style-type: none"> - can design, evaluate and compare different concepts for the design and development of a software system based on given application scenarios, - can devise and compare concepts for the analysis and maintenance of a given system and put these concepts into practice, - acquire practical experience in the development of software systems, in particular in view of the interaction of software with its technical environment, - acquire experience in handling software systems and tools that are of particular importance for software systems engineering; - acquire subject-specific theoretical, methodological and practical knowledge and expand their learning skills. <p>Courses assigned to this module are offered in English.</p>			
Module (partial) examinations (number, form, scope):	Exam types: Written exam (90–120 mins.) Oral exam (30–45 mins.)			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in semester hours)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Lecture (lecture)	3	-	-	-
Exercise (exercise)	1	-	Exercise tasks (50%)	-
Offered:	SoSe			
Prerequisite for module participation:	None			
Department:	Digital Engineering (HPI)			

HPI-SSE-EL: Ethics, Law and Compliance (Software Systems Engineering)		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Mandatory module			
Module content and qualification goals:	<p><i>Content</i></p> <p>This module provides an overview of ethical and legal issues in software systems engineering. It also includes ethical and legal issues that arise when creating and using software systems, such as in the handling of personal data, liability, copyright and licensing. These are questions that must be considered both in a national and in an international context, for example when using cloud services. The larger context, as it concerns the connection between potential software developments and people and society, must also be taken into account. This topic area includes ethical questions about artificial intelligence and automation. In times of globally available and networked software systems, the objective is not only to recognize legal risks and to be able to act with legal certainty, but also to be able to ethically evaluate critical scenarios and prevent them from occurring.</p> <p><i>Qualification goals</i></p> <p>Students acquire detailed knowledge of the subject matter in the module.</p> <p>Students:</p> <ul style="list-style-type: none"> - acquire subject-specific, theoretical, methodological and practical knowledge, - learn to measure the ethical implications of potential software systems scenarios, - learn relevant national and international law, such as the data protection law, - are able to assess legally and ethically international services, e.g., cloud services, - can properly select solution concepts appropriate to ethical questions, - gain experience in the formalization and abstraction of problems, - learn approaches to leadership skills, practice conflict management in a team. <p>Courses assigned to this module are offered in English.</p>			
Module (partial) examinations (number, form, scope):	<p>Exam types:</p> <p>Written exam (90–120 mins.)</p> <p>Oral exam (30–45 mins.)</p> <p>Paper (min. 8 pgs.) together with a presentation of research results (20-45 min. talk)</p>			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in semester hours)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Projektseminar/Seminar/Vorlesung (Vorlesung oder Seminar)	4	-	Interim presentation (15 min.)	-
Offered:		WiSe		
Prerequisite for module participation:		None		
Department:		Digital Engineering (HPI)		

HPI-SSE-L: Software Systems Engineering Lab		Number of credit points (CP): 12		
Module type (mandatory or elective module):	Mandatory module			
Module content and qualification goals:	<p><i>Content</i> In the Software Systems Engineering Lab, students work together in a group on a selected, <i>research-related question</i> from a specific sub-area of the degree program. The question is analyzed and a solution is designed for a sub-area. This solution is applied constructively and is also scientifically documented. Solutions are evaluated continually for their strengths and weaknesses. A comparative evaluation with other techniques and algorithms serves to deepen the practical understanding. Students gain deep insights into current research in the subject areas and participate in the development of novel solutions. In this module, the scientific education is thereby deepened. The work takes place in project groups of usually at least three and, at most, six students. Each Software Systems Engineering Lab is led by an authorized examiner.</p> <p><i>Qualification goals</i> In this module, knowledge from advanced modules in Software Systems Engineering is applied to research practice. Students</p> <ul style="list-style-type: none"> - gain the ability to design and develop complex software systems as a solution for concrete applications and to evaluate them comparatively, - gain competencies through their work in teams in the field of project management, - become familiar with collaborative and distributed modes of work, - practice skills in teamwork, communication and conflict management, - learn how to deal systematically with research questions and primary and secondary literature. <p>Courses assigned to this module are offered in English.</p>			
Module (partial) examinations (number, form, scope):	Talk (30-45 min.) together with a paper (min. 8 pgs.) and the demonstration of a developed computer program (20-30 min.).			
Self-study time (in hours [h]):	240			
Courses (teaching format)	Contact time (in semester hours)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Project activity (Project)	8	-	Interim presentation (15 min.)	-
Offered:	WiSe and SoSe			
Prerequisite for module participation:	None			
Department:	Digital Engineering (HPI)			

HPI-DSYS-C: Data-Driven Systems - Concepts and Methods (Software Systems Engineering)		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Elective module			
Module content and qualification goals:	<p><i>Content</i></p> <p>Given the immense amounts of data processed in modern software systems, together with the significant requirements in terms of efficiency, scalability, resilience and data protection, many system architectures have to be designed from the ground up based on relevant data access patterns and data flows. This undertaking requires efficient concepts and methods for storing and querying data and the scalable processing of data. Compliance with relevant criteria such as correctness, resilience and security is required. This module teaches important concepts and methods to assess and develop complex data-driven software systems or information systems based on such criteria.</p> <p><i>Qualification goals</i></p> <p>Students:</p> <ul style="list-style-type: none"> - learn methods for designing and developing complex, data-driven system architectures, - learn implementation concepts and algorithms, - expand their professional judgement skills, - are able to independently develop and use suitable sources of information to solve problems, - learn how to independently follow up on a topic based on primary and secondary literature, - gain experience in the formalization and abstraction of problems. <p>Courses assigned to this module are offered in English.</p>			
Module (partial) examinations (number, form, scope):	<p>Exam types:</p> <p>Written exam (90–120 mins.)</p> <p>Oral exam (30–45 mins.)</p> <p>Paper (min. 8 pgs.) together with a presentation of research results (20-45 min. talk)</p>			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in semester hours)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Lecture/seminar (lecture or seminar)	4	-	Exercise tasks (50%)	-
Offered:		WiSe		
Prerequisite for module participation:		None		
Department:		Digital Engineering (HPI)		

HPI-DSYS-T: Data-Driven Systems - Technologies and Tools (Software Systems Engineering)		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Elective module			
Module content and qualification goals:	<p><i>Content</i> This module provides in-depth practical knowledge about <i>data-driven systems</i> using common software tools. Classic, often monolithic information system architectures are compared with those of the current state of the art, which favor more efficient distributed data processing or hardware-related operations. The advantages and disadvantages of classic techniques are shown and the limitations of the current state of the art examined. Students become sensitized to open problems and are instructed in how to develop their own solutions to these open research questions.</p> <p><i>Qualification goals</i> Students:</p> <ul style="list-style-type: none"> - learn the practical mastery of scalable system architectures for software systems, - are able to independently solve problems and to develop and use suitable sources of information to solve problems, - learn how to independently gain a deep understanding of a topic on the basis of primary and secondary literature, - are able to select and apply appropriate solution concepts and strategies to a given problem. <p>Courses assigned to this module are offered in English.</p>			
Module (partial) examinations (number, form, scope):	<p>Exam types: Written exam (90–120 mins.) Oral exam (30–45 mins.) Paper (min. 8 pgs.) together with a presentation of research results (20-45 min. talk)</p>			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in semester hours)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Lecture/seminar (lecture or seminar)	4	-	Exercise tasks (50%)	-
Offered:	SoSe			
Prerequisite for module participation:	None			
Department:	Digital Engineering (HPI)			

HPI-DSYS-S: Data-Driven Systems - Specialization (Software Systems Engineering)		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Elective module			
Module content and qualification goals:	<p><i>Content</i></p> <p>This module gives participants an understanding of current research questions and results on the topic of data-intensive systems and information systems. The focus is particularly on the identification of weaknesses in the current state of the art and the scientific development of advanced techniques for the design of scalable system architectures, which includes relevant data architectures and data pipelines. Innovations due to new hardware paradigms can also come into play. The investigation is mainly carried out using one or more targeted application scenarios.</p> <p><i>Qualification goals</i></p> <p>Students:</p> <ul style="list-style-type: none"> - work out limitations and extensions of existing scalable data-intensive systems, - learn the scientific process for current research questions in the area of scalable, data-driven software systems, - acquire subject-specific theoretical, methodical and practical knowledge, - can select and apply appropriate solutions and strategies to a given problem, - are able to independently investigate and evaluate scientific literature on an individual topic, - gain experience in the formalization and abstraction of problems, - become familiar with the criteria and principles of scientific writing, - learn methods for the presentation and defense of completed tasks. <p>Courses assigned to this module are offered in English.</p>			
Module (partial) examinations (number, form, scope):	<p>Exam types:</p> <p>Written exam (90–120 mins.)</p> <p>Oral exam (30–45 mins.)</p> <p>Paper (min. 8 pgs.) together with a presentation of research results (20-45 min. talk)</p>			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in SWS)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Lecture/seminar (lecture or seminar)	4	-	Exercise tasks (50%)	-
Offered:	WiSe and SoSe			
Prerequisite for module participation:	Previous participation in HPI-DSYS-C or HPI-DSYS-T is recommended.			
Department:	Digital Engineering (HPI)			

HPI-MALA-C: Machine Learning and Analytics - Concepts and Methods (Software Systems Engineering)		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Elective module			
Module content and qualification goals:	<p><i>Content</i> The significant advances in data analysis have opened up many new application scenarios. While in the classic programming of a software system all individual program steps are specified, modern data analysis and machine learning enable the behavior of a system to be learned automatically based on sample data. This opens up entirely new application scenarios, such as those in the areas of artificial intelligence, computer vision and natural language processing. In fact, many problems seem to be solvable only through such learning. This can be examined for many new applications, such as those in medicine and health or in e-commerce and trade. This module teaches basic concepts and methods for <i>analyzing data</i>, including those for visualizing and extracting interesting relationships and unexpected patterns, as well as those for learning application-specific models using methods from machine learning.</p> <p><i>Qualification goals</i> Students acquire detailed knowledge of the subject matter covered in the module. Students:</p> <ul style="list-style-type: none"> - acquire detailed knowledge of methods in the areas of data analysis and machine learning, - are able to assess and compare different methods for analysis and learning in view of their effectiveness and applicability, - can design appropriate models and software systems based on a data record, - understand which problems are currently open in the field of data analytics and machine learning, thereby gaining insight into the relevant state of research. <p>Courses assigned to this module are offered in English.</p>			
Module (partial) examinations (number, form, scope):	<p>Exam types: Written exam (90–120 mins.) Oral exam (30–45 mins.) Paper (min. 8 pgs.) together with a presentation of research results (20-45 min. talk)</p>			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in SWS)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Lecture/seminar (lecture or seminar)	4	-	Exercise tasks (50%)	-
Offered:	WiSe			
Prerequisite for module participation:	None			
Department:	Digital Engineering (HPI)			

HPI-MALA-T: Machine Learning and Analytics - Technologies and Tools (Software Systems Engineering)		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Elective module			
Module content and qualification goals:	<p><i>Content</i></p> <p>This module provides in-depth practical knowledge in the field of machine learning and data analytics using common software libraries and tools. Based on concrete questions from application domains in business or medicine, practical examples for <i>data exploration and extraction</i> as well as for machine learning are empirically examined. Various machine learning approaches are taught such as clustering and classification, probabilistic models, deep learning and visual analytics. The strengths and weaknesses are considered for each step with regard to the current state of the art. Students are sensitized to open research problems and develop their own techniques and tools to solve these research questions.</p> <p><i>Qualification goals</i></p> <p>Students acquire detailed knowledge of the subject matter covered in the module.</p> <p>Students:</p> <ul style="list-style-type: none"> - learn the application of various approaches to data analysis and machine learning, such as clustering and classification, - learn the practical application of data analysis methods and systems, - acquire the ability to use common software tools, to pre-process and analyze raw data, and to learn prediction models based on this analysis, - acquire the ability to select and implement appropriate solution concepts and strategies to a given problem, - expand their professional competencies, - improve their learning skills. <p>Courses assigned to this module are offered in English.</p>			
Module (partial) examinations (number, form, scope):	<p>Exam types:</p> <p>Written exam (90–120 min.)</p> <p>Oral exam (30–45 min.)</p> <p>Paper (min. 8 pgs.) together with a presentation of research results (20–45 min. talk)</p>			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in SWS)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Lecture/seminar (lecture or seminar)	4	-	Exercise tasks (50%)	-
Offered:	SoSe			
Prerequisite for module participation:	None			
Department:	Digital Engineering (HPI)			

HPI-MALA-S: Machine Learning and Analytics - Specialization (Software Systems Engineering)		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Elective module			
Module content and qualification goals:	<p><i>Content</i> This module covers current research questions and results from the theory and practice of machine learning, data science and artificial intelligence. The focus of the module is on identifying weaknesses in the current state of research and on the scientific <i>development of advanced methods and systems in the field of machine learning and data analytics</i>. We consider open research questions from, for example, the areas of deep learning and representation learning, explainability and optimization. Fields of application such as computer vision, natural language processing, multimedia analytics and medical applications are considered.</p> <p><i>Qualification goals</i> Students acquire detailed knowledge of the subject matter covered in the module. Students:</p> <ul style="list-style-type: none"> - work through limitations and extensions of existing methods of machine learning and data analytics, - learn the scientific process for current research questions in the field of machine learning and data analytics, - learn to independently follow up a topic on the basis of primary and secondary literature, - learn to independently identify and work with subject-specific literature and to apply its content, - learn how to present and critically discuss completed tasks, - expand their learning skills, - develop discussion skills and techniques. <p>Courses assigned to this module are offered in English.</p>			
Module (partial) examinations (number, form, scope):	<p>Exam types: Written exam (90–120 min.) Oral exam (30–45 min.) Paper (min. 8 pgs.) together with a presentation of research results (20-45 min. talk)</p>			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in SWS)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Lecture/seminar (lecture or seminar)	4	-	Exercise tasks (50%)	-
Offered:	WiSe and SoSe			
Prerequisite for module participation:	Previous participation recommended in HPI-MALA-C or HPI-MALA-T.			
Department:	Digital Engineering (HPI)			

HPI-MODA-C: Models and Algorithms - Concepts and Methods (Software Systems Engineering)		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Elective module			
Module content and qualification goals:	<p><i>Content</i></p> <p>In view of the considerable complexity of modern software systems as well as the ever-growing amounts of data that are being processed in such systems, many practical questions can only be solved with new modeling approaches and new algorithmic processes. This module teaches specialized knowledge of such approaches and processes. Content includes formal and theoretical means for the analysis of software systems and algorithms as well as concepts for the development of new algorithmic processes. This takes into account application-specific requirements such as efficiency, scalability, reliability and formal correctness. It also includes new programming models for using specific computer architectures, such as quantum computing, parallel computing or edge computing.</p> <p><i>Qualification goals</i></p> <p>Students acquire detailed knowledge of the subject matter covered in the module.</p> <p>Students:</p> <ul style="list-style-type: none"> - achieve subject-specific theoretical and methodological knowledge, - can select and apply suitable solution concepts and strategies to a given problem, - expand their professional decision-making skills, - acquire experience in the design and the formal analysis of software systems. - are able to independently develop and use suitable sources of information to solve problems, - expand their learning skills. <p>Courses assigned to this module are offered in English.</p>			
Module (partial) examinations (number, form, scope):	<p>Exam types:</p> <p>Written exam (90–120 min.)</p> <p>Oral exam (30–45 min.)</p> <p>Paper (min. 8 pgs.) together with a presentation of research results (20–45 min. talk)</p>			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in SWS)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Lecture/seminar (lecture or seminar)	4		Exercise tasks (50%)	
Offered:	WiSe			
Prerequisite for module participation:	None			
Department:	Digital Engineering (HPI)			

HPI-MODA-T: Models and Algorithms – Technologies and Tools (Software Systems Engineering)		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Elective module			
Module content and qualification goals:	<p><i>Content</i></p> <p>This module provides in-depth knowledge of modeling approaches and algorithmic processes related to complex software systems. It includes techniques to meet the requirements of complex software systems from an application and development perspective, especially with regard to fundamental characteristics such as scalability and efficiency. New computer architectures and programming models are included as well. In addition to practical procedures, the module covers formal and theoretical means that can contribute to a better understanding of the basic properties of a software system or procedure. The limits of existing techniques are explored and students are instructed in developing their own approaches to solving these open research questions.</p> <p><i>Qualification goals</i></p> <p>Students:</p> <ul style="list-style-type: none"> - acquire subject-specific methodological and practical knowledge of modelling and algorithms in connection with software systems engineering, - expand their professional decision-making skills, - are able to independently solve problems relating to various kinds of software systems and computer models and to develop and apply appropriate sources of information, - are able to solve problems regarding different types of algorithms by independently developing and applying appropriate sources of information, - learn how to independently follow up on a topic by using primary and secondary literature, - are able to follow current research trends and to integrate them in their work, - can select and apply appropriate solution concepts and strategies to a given problem. <p>Courses assigned to this module are offered in English.</p>			
Module (partial) examinations (number, form, scope):	<p>Exam types:</p> <p>Written exam (90–120 min.)</p> <p>Oral exam (30–45 min.)</p> <p>Paper (min. 8 pgs.) together with a presentation of research results (20–45 min. talk)</p>			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in SWS)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Lecture/seminar (lecture or seminar)	4		Exercise tasks (50%)	
Offered:	SoSe			
Prerequisite for module participation:	None			
Department:	Digital Engineering (HPI)			

HPI-MODA-S: Models and Algorithms - Specialization (Software Systems Engineering)		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Elective module			
Module content and qualification goals:	<p><i>Content</i></p> <p>This module explores current research questions and findings in the specialization area of models and algorithms. The focus here is on a critical examination of such models and approaches and the scientific as well as practical ongoing development of the state of the art. Open research questions are addressed, for example from the areas of theoretical computer science and algorithms, systems modelling, quantum computing, cryptography and formal methods of security.</p> <p><i>Qualification goals</i></p> <p>Students:</p> <ul style="list-style-type: none"> - work through limitations and extensions of existing models and algorithms, - learn modern research approaches to mitigate such limitations, - gain experience in the formalization and abstraction of problems, - learn the scientific process for current research questions regarding modelling and algorithms, - can select and apply appropriate solution concepts and strategies to a given problem, - are able to follow current research trends in complex software systems and to integrate them into their work, - are able to independently develop and evaluate scientific literature on individual topics, - become familiar with criteria and principles of scientific writing, - learn methods for the presentation and defense of completed tasks. <p>Courses assigned to this module are offered in English.</p>			
Module (partial) examinations (number, form, scope):	<p>Exam types:</p> <p>Written exam (90–120 min.)</p> <p>Oral exam (30–45 min.)</p> <p>Paper (min. 8 pgs.) together with a presentation of research results (20–45 min. talk)</p>			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in SWS)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Lecture/seminar (lecture or seminar)	4		Exercise tasks (50%)	
Offered:	WiSe and SoSe			
Prerequisite for module participation:	Previous participation recommended in HPI-MODA-C or HPI-MODA-T.			
Department:	Digital Engineering (HPI)			

HPI-OISY-C: Online and Interactive Systems - Concepts and Methods (Software Systems Engineering)		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Elective module			
Module content and qualification goals:	<p><i>Content</i> Nowadays, software systems can no longer be regarded as operating in an isolated manner. Rather, they interact with the external world through network communication with other systems on the one hand, and through interaction with people on the other. Increased global networking lies at the heart of this development, which includes, for example, Internet of Things devices. This is a fact that must be given special consideration when developing software systems, especially since many solutions are designed and developed from the ground up as decentralized networked systems. At the same time, the interaction with people and with the real world is of prime importance since mobile devices play an increasingly important role in everyday human life. This ever-greater role is evident in the many new possibilities available today, such as VR/AR technology, wearable technology and 3D printers. Against this background, this module provides in-depth knowledge of the development and analysis of online and interactive systems in areas that include Internet technology, mobile devices, network technology and human-computer interaction. Further aspects also given particular emphasis include cybersecurity, privacy and data protection.</p> <p><i>Qualification goals</i> Students acquire detailed knowledge of the subject matter covered in the module. Students:</p> <ul style="list-style-type: none"> - acquire subject-specific theoretical and methodological knowledge of <i>online systems</i> and <i>interactive systems</i>, - can select, evaluate and apply suitable solution concepts and strategies to a given problem, - expand their decision-making competency, - are able to independently develop and use suitable sources of information to solve problems, - learn how to independently follow up on a topic on the basis of primary and secondary literature, - improve their learning skills. <p>Courses assigned to this module are offered in English.</p>			
Module (partial) examinations (number, form, scope):	Exam types: Written exam (90–120 min.) Oral exam (30–45 min.) Paper (min. 8 pgs.) together with a presentation of research results (20-45 min. talk)			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in SWS)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Lecture/seminar (lecture or seminar)	4		Exercise tasks (50%)	
Offered:	WiSe			
Prerequisite for module participation:	None			
Department:	Digital Engineering (HPI)			

HPI-OISY-T: Online and Interactive Systems – Technologies and Tools (Software Systems Engineering)		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Elective module			
Module content and qualification goals:	<p><i>Content</i> This module provides in-depth knowledge in the field of online and interactive systems by considering theoretical and practical approaches to the interface between people and systems on the one hand, and between multiple different systems on the other, considered with regard to strengths as well as weaknesses. Relevant here, for example, are online learning platforms, mobile applications, new input modalities, wearable technology, and new manufacturing processes such as 3D printing but also wireless networks. Students are made aware of open research problems and develop their own techniques and tools to solve these research questions.</p> <p><i>Qualification goals</i> Students acquire detailed knowledge of the subject matter covered in the module. Students:</p> <ul style="list-style-type: none"> - acquire subject-specific methodological and practical knowledge of online systems and interactive systems, - expand their professional decision-making skills, - are able to develop and apply appropriate sources of information to solve problems involving different kinds of online and interactive scenarios, - learn how to independently follow up on a topic on the basis of primary or secondary literature, - are able to follow current research trends and to integrate them into their work, - can select and apply suitable solution concepts and strategies to a given problem, - gain the ability to use common tools for the development of online or interactive systems. <p>Courses assigned to this module are offered in English.</p>			
Module (partial) examinations (number, form, scope):	<p>Exam types: Written exam (90–120 min.) Oral exam (30–45 min.) Paper (min. 8 pgs.) together with a presentation of research results (20–45 min. talk)</p>			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in SWS)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Lecture/seminar (lecture or seminar)	4		Exercise tasks (50%)	
Offered:	SoSe			
Prerequisite for module participation:	None			
Department:	Digital Engineering (HPI)			

HPI-OISY-S: Online and Interactive Systems - Specialization (Software Systems Engineering)		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Elective module			
Module content and qualification goals:	<p><i>Content</i> This module specializes in certain aspects of <i>online and interactive systems</i> by focusing on current research questions and results. Topics from areas such as the Internet, cloud technology, human-computer interaction, cyber security, and network technology are reflected in the current state of research and examined in detail. In this module, the focus is on current developments in science, business or politics and the new research questions associated with them.</p> <p><i>Qualification goals</i> Students:</p> <ul style="list-style-type: none"> - work through limitations and extensions of existing online solutions and interaction paradigms, - delve into modern research approaches on mitigating such limitations, - learn the scientific process for current research questions in the area of online and interactive systems, - acquire subject-specific theoretical, methodical and practical knowledge, - can select and apply suitable solution concepts and strategies to a given problem, - are able to independently develop and evaluate scientific literature on individual topics, - gain experience in the formalization and abstraction of problems, - become familiar with the criteria and principles of scientific writing, - learn methods for presenting and defending completed tasks. <p>Courses assigned to this module are offered in English.</p>			
Module (partial) examinations (number, form, scope):	<p>Exam types: Written exam (90–120 min.) Oral exam (30–45 min.) Paper (min. 8 pgs.) together with a presentation of research results (20-45 min. talk)</p>			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in SWS)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Lecture/seminar (lecture or seminar)	4		Exercise tasks (50%)	
Offered:	WiSe and SoSe			
Prerequisite for module participation:	Previous participation recommended in HPI-OISY-C or HPI-OISY-T.			
Department:	Digital Engineering (HPI)			

HPI-SSYS-C: Software Systems - Concepts and Methods (Software Systems Engineering)		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Elective module			
Module content and qualification goals:	<p><i>Content</i> The specialization area “software systems,” in the Software Systems Engineering major, focuses on processes, techniques, concepts and methods for the development of complex software systems. This module presents the concepts and methods of software systems engineering and includes, in particular, topics from the areas of operating systems and system-related software, networked and distributed systems, software engineering, and enterprise software and middleware. Within these subject areas, basic and advanced concepts and requirements for complex software systems are covered, including correctness, efficiency, scalability and maintainability.</p> <p><i>Qualification goals</i> Students acquire detailed knowledge of the subject matter covered in the module. Students:</p> <ul style="list-style-type: none"> - acquire subject-specific theoretical and methodological knowledge and skills, - can select and apply suitable solution concepts and strategies to a given subject or develop and evaluate new concepts, - expand their professional skills of decision-making, - gain experience in designing software systems, - are able to solve problems independently by developing and using appropriate sources of information, - expand their learning skills. <p>Courses assigned to this module are offered in English.</p>			
Module (partial) examinations (number, form, scope):	<p>Exam types: Written exam (90–120 min.) Oral exam (30–45 min.) Paper (min. 8 pgs.) together with a presentation of research results (20–45 min. talk)</p>			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in SWS)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Lecture/seminar (lecture or seminar)	4		Exercise tasks (50%)	
Offered:	WiSe			
Prerequisite for module participation:	None			
Department:	Digital Engineering (HPI)			

HPI-SSYS-T: Software Systems – Technologies and Tools (Software Systems Engineering)		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Elective module			
Module content and qualification goals:	<p><i>Content</i> This module provides in-depth practical knowledge and skills in the area of software systems. The focus is on modern techniques and tools from science and industry. Participants focus on how the requirements from the perspective of application and development, as well as those from the perspective of deployment and operation, can be met in complex software systems. Concrete techniques, including those for highly scalable, widely distributed software systems are covered. In the process, the limits of known techniques are exposed and students are instructed on how to develop their own approaches for solving these open research questions.</p> <p><i>Qualification goals</i> Students:</p> <ul style="list-style-type: none"> - acquire subject-specific methodological and practical knowledge for the analysis, development, and extension of software systems, - increase their professional decision-making skills, - are able to independently develop and apply suitable sources of information in solving problems related to various types of complex software systems, - learn how to independently follow up on a topic on the basis of primary and secondary literature, - are able to follow current research trends and to integrate these into their work, - can select and apply appropriate solution concepts and strategies to a given problem. <p>Courses assigned to this module are offered in English.</p>			
Module (partial) examinations (number, form, scope):	<p>Exam types: Written exam (90–120 min.) Oral exam (30–45 min.) Paper (min. 8 pgs.) together with a presentation of research results (20–45 min. talk)</p>			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in SWS)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Lecture/seminar (lecture or seminar)	4		Exercise tasks (50%)	
Offered:	SoSe			
Prerequisite for module participation:	None			
Department:	Digital Engineering (HPI)			

HPI-SSYS-S: Software Systems - Specialization (Software Systems Engineering)		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Elective module			
Module content and qualification goals:	<p><i>Content</i> This module deals with current research questions and findings in the specialization area <i>Software Systems</i>. In particular, students explore the identification of limitations in relevant techniques and tools as well as the scientific development of the state of the art. This is carried out primarily by considering specific applications, development and deployment scenarios of software systems.</p> <p><i>Qualification goals</i> Students:</p> <ul style="list-style-type: none"> - work through the limitations and extensions of existing techniques in the field of software systems, - deal with modern research approaches to mitigate such limitations, - learn the scientific process for current research questions in the area of software systems, - can select and apply appropriate concepts and strategies for a given problem, - are able to follow current research trends in complex software systems and to integrate them into their work, - are able to independently investigate and evaluate scientific literature on individual topics, - gain experience in the formalization and abstraction of problems with different types of complex software systems, - become familiar with criteria and principles of scientific writing, - learn methods for the presentation and the defense of completed tasks. <p>Courses assigned to this module are offered in English.</p>			
Module (partial) examinations (number, form, scope):	<p>Exam types: Written exam (90–120 min.) Oral exam (30–45 min.) Paper (min. 8 pgs.) together with a presentation of research results (20-45 min. talk)</p>			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in SWS)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Lecture/seminar (lecture or seminar)	4		Exercise tasks (50%)	
Offered:	WiSe and SoSe			
Prerequisite for module participation:	Previous participation recommended in HPI-SSYS-C or HPI-SSYS-T.			
Department:	Digital Engineering (HPI)			

HPI-PSK-ML: Management und Leadership		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Dependent on Major			
Module content and qualification goals:	<p><i>Content</i> This module teaches the management skills necessary for planning and leading complex IT or Big Data projects, as well as those skills required for general management and strategic corporate management. Participants engage in offers that include the areas of methodological skills, negotiation competency, and social and personal skills.</p> <p><i>Qualification goals</i> Students acquire detailed knowledge of the subject matter covered in the module. Students:</p> <ul style="list-style-type: none"> - acquire subject-specific and methodological knowledge, - gain knowledge in topics including continuous strategic and organizational change and change management, - gain experience in assuming responsibility, - gain self-organization know-how, - acquire planning skills, - acquire gender and diversity skills, - learn the management of teams and teamwork, and how to cope with collaborative problem-solving and complex tasks, - practice conflict management in a team, - learn approaches to leadership and management skills, - gain experience in assuming responsibility, - build performance stamina. 			
Module (partial) examinations (number, form, scope):	<p>Exam types: Written exam (90–120 min.) Oral exam (30–45 min.) Paper (min. 8 pgs.) together with a presentation of research results (20-45 min. talk)</p>			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in SWS)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Lecture/seminar (lecture or seminar)	4	-	Interim presentation (15 min.)	-
Offered:	WiSe and SoSe			
Prerequisite for module participation:	None			
Department:	Digital Engineering (HPI)			

HPI-PSK-KT: Technology-Communication and Transfer		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Elective module			
Module content and qualification goals:	<p><i>Content</i> This module teaches different types of oral and written communication skills that play a role in various professional contexts of digital engineering in both science and industry. Emphasis is always on the oral and written delivery of subject-specific knowledge to various target groups. This module covers aspects of the preparation and execution of (scientific) presentations and lectures. Students learn techniques of pitch and presentation, communication management and technical writing. Additionally, students learn how written communication differs from other types of interaction among those parties involved and how to optimally convey contents in various media.</p> <p><i>Qualification goals</i> Students acquire detailed knowledge of the subject matter covered in the module. Students:</p> <ul style="list-style-type: none"> - gain subject-specific theoretical and methodological knowledge, - can select and apply appropriate solution concepts and strategies to a given problem, - practice appropriate communication in different professional contexts, in particular against the background of the interaction partner's prior experience, - practice communication skills, - learn presentation techniques in physical and digital contexts, - gain experience working in a team and carrying out collaborative problem-solving, - practice mastering conflict in the team. 			
Module (partial) examinations (number, form, scope):	<p>Exam types: Written exam (90–120 min.) Oral exam (30–45 min.) Paper (min. 8 pgs.) together with a presentation of research results (20-45 min. talk)</p>			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in semester hours)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Project seminar/seminar/lecture (lecture or seminar)	4	-	Interim presentation (15 min.)	-
Offered:		WiSe and SoSe		
Prerequisite for module participation:		None		
Department:		Digital Engineering (HPI)		

HPI-PSK-DT: Design Thinking		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Elective module			
Module content and qualification goals:	<p><i>Content</i> This module teaches the principles, techniques and processes of Design Thinking, a user-centric approach to designing innovations. The Design Thinking process combines methods and tools from the fields of design, engineering and business administration. The approach uses methods and tools to determine the latent desires and needs of future customers. This user-orientation is combined with the perspective of technological feasibility and economic viability. A team-based approach, it not only relies on the creativity of the individual, but also, and in particular, on collaboration and cooperation. In this module, the techniques are practiced with project partners using concrete project questions. The module also provides methods and procedures for investigating how the adaptation and integration of human-centered design (HCD) and Design Thinking in companies leads to sustainable business innovations.</p> <p><i>Qualification goals</i> Students acquire detailed knowledge of the subject matter covered in the module. Students:</p> <ul style="list-style-type: none"> - acquire subject-specific theoretical and methodical knowledge, - develop their creativity and put it into practice, - learn to present their completed task and justify their decisions when critiqued, - learn how to work on their own contribution in a collaborative team, - learn to work with others in a team and to master complex tasks collaboratively, - practice team skills and collaborative problem-solving, - practice conflict management in a team, - learn leadership skills, - gain experience in assuming responsibility. 			
Module (partial) examinations (number, form, scope):	<p>Exam types: Oral exam (30–45 min.) Paper (min. 8 pgs.) together with a presentation of research results (20-45 min. talk) Paper (min. 12 pgs.)</p>			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in semester hours)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Project seminar/seminar/lecture (lecture or seminar)	4	-	Interim presentation (15 min.)	-
Offered:	WiSe and SoSe			
Prerequisite for module participation:	None			
Department	Digital Engineering (HPI)			

HPI-PSK-EI: Entrepreneurship und Innovation		Number of credit points (CP): 6		
Module type (mandatory or elective module):	Elective module			
Module content and qualification goals:	<p><i>Content</i> This module teaches practical and theoretical knowledge in the area of entrepreneurship, as well as technology and innovation management. Students learn entrepreneurial thinking and action-taking. They receive the necessary skills to find solutions for problems, generate ideas and, from them, derive business models. Not only do they become familiar with the challenges of founding a company, but they also get the motivation to start a company themselves. The module also deals with instruments from the fields of empirical social research, business modelling, Design Thinking, lean start-up and strategic technology.</p> <p><i>Qualification goals</i> Students acquire detailed knowledge of the subject matter covered in the module. Students:</p> <ul style="list-style-type: none"> - acquire subject-specific theoretical and methodological knowledge, - learn a science-oriented way of thinking and working, - work on solving concrete problems in a team, - develop and try out their creativity, - present completed tasks and justify their decisions in the face of critique, - learn to work independently on separate contributions in the group - practice teamwork and problem solving, - practice conflict management in the team, - learn approaches to leadership skills, - gain experience in assuming responsibility. 			
Module (partial) examinations (number, form, scope):	<p>Exam types: Written exam (90–120 min.) Oral exam (30–45 min.) Paper (min. 8 pgs.) together with a presentation of research results (20-45 min. talk)</p>			
Self-study time (in hours [h]):	120			
Courses (teaching format)	Contact time (in semester hours)	Supplementary exam requirements (number, form, scope)		Course accompanying module (partial) exam(s) (number, form, scope)
		For completion of module	For admission to module exam	
Project seminar/seminar/lecture (lecture or seminar)	4	-	Interim presentation (15 min.)	-
Offered:	WiSe and SoSe			
Prerequisite for module participation:	None			
Department:	Digital Engineering (HPI)			