Department MATHEMATIK

FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG

NATURWISSENSCHAFTLICHE
FAKULTÄT

Modulhandbuch

für den Studiengang

Data Science (M.Sc.)

Wintersemester 2021/22

Stand: 29.08.2021

Hinweise:

- Weitere Informationen zu den einzelnen Studiengängen (Studien- und Prüfungsordnungen, Studienberatung, etc.) finden Sie auf

  www.math.fau.de/studium

- Semesteraktuelle Informationen zu den angebotenen Lehrveranstaltungen finden Sie im UnivIS-Vorlesungsverzeichnis.

- Module eines Studiengangs sind in der jeweiligen Prüfungsordnung festgelegt. Diese Sammlung umfasst die Module, die vom Department Mathematik in den jeweiligen Studiengängen verwendet werden.

Inhaltsverzeichnis

Englische Module

1	**Module name**	**AlgNLOpt: Advanced Algorithms for Nonlinear Optimization**	**ECTS 5**
2	**Courses/lectures**	a) Lecture: 2 semester hrs/week b) Practical: 0.5 semester hrs/week	
3	**Lecturers**	Prof. Dr. Michael Stingl michael.stingl@fau.de	
4	**Module coordinator**	Prof. Dr. Michael Stingl michael.stingl@fau.de	
5	**Content**	Several of the following topics: • Trust region methods • Iterative methods in the presence of noisy data • Interior point methods for nonlinear problems • Modified barrier and augmented Lagrangian methods • Local and global convergence analysis	
6	**Learning objectives and skills**	Students • use methods of nonlinear constrained optimization in finite dimensional spaces, • analyse convergence behaviour of these methods and derive robust and efficient realisations, • apply these abilities to technical and economic applications.	
7	**Prerequisites**	Basic knowledge in nonlinear optimization is recommended.	
8	**Integration into curriculum**	1st semester	
9	**Module compatibility**	• Mandatory elective module for MSc in Computational and Applied Mathematics • Mandatory elective module for MSc in Mathematics in the field of study “Modelling, Simulation and Optimization” • Mandatory elective module for the MSc in Mathematics and Economics in the field of study “Optimization and process management”	
10	**Method of examination**	oral exam (15 minutes)	
11	**Grading Procedure**	100% based on oral exam	
12	**Module frequency**	Winter semester (not annually) To check whether the course is offered, see UnivIS univis.fau.de or module handbook of current semester	
13	**Workload**	Contact hours: 37.5 hrs Independent study: 112.5 hrs Total: 150 hrs, corresponding to 5 ECTS credits	
14	**Module duration**	One semester	
15	**Teaching and examination language**	English	
16	**Recommended reading**	• C.T. Kelley: Iterative Methods for Optimization, SIAM, • J. Nocedal & S. Wright: Numerical Optimization, Springer.	

	Module name	AdDiscTech: Advanced Discretization Techniques	ECTS 10
2	Courses/lectures	a) Lecture: 4 semester hrs/week b) Practical: 1 semester hr/week	
3	Lecturers	Prof. Dr. Eberhard Bänsch baensch@math.fau.de	
4	Module coordinator	Prof. Dr. Eberhard Bänsch baensch@math.fau.de	
5	Content	• conforming and non-conforming finite element methods • saddle point problems in Hilbert spaces • mixed finite element methods for saddle point problems, in particular for Darcy and Stokes • Streamline-Upwind Petrov-Galerkin (SUPG) and discontinuous Galerkin (dG) finite element methods (FEM) for convection dominated problems • Finite Volume (FV) methods and their relation to FEM • a posteriori error control and adaptive methods	
6	Learning objectives and skills	Students • have a discriminating understanding, both theoretically and computationally of FE as well as FV methods for the numerical solution of partial differential equations (pde) (in particular of saddle point problems), • are capable of developing problem dependent FE or FV methods and judge on their properties regarding stability and effectiveness, • are familiar with a broad spectrum of pde problems and their computational solutions, • are capable of designing algorithms for adaptive mesh control.	
7	Prerequisites	Recommended: Introduction to numerical methods for PDEs, Functional analysis	
8	Integration into curriculum	1st semester	
9	Module compatibility	Mandatory elective module for MSc in Computational and Applied Mathematics Compulsory elective module for MSc in Mathematics	
10	Method of examination	oral exam (15 minutes)	
11	Grading Procedure	100% based on oral exam	
12	Module frequency	Winter semester (annually)	
13	Workload	Contact hours: 75 hrs Independent study: 225 hrs Total: 300 hrs, corresponding to 10 ECTS credits	
14	Module duration	One semester	
15	Teaching and examination language	English	

16	**Recommended reading**	• A. Ern, J.-L. Guermond: Theory and Practice of Finite Elements • A. Quarteroni & A. Valli: Numerical Approximation of Partial Differential Equations • P. Knabner & L. Angermann: Numerical Methods for Elliptic and Parabolic Differential Equations, Springer • D. A. Di Piettro & A. Ern: Mathematical aspects of discontinuous Galerkin methods. Springer 2012

1	**Module name**	**Module ArtIntI: Artificial Intelligence I**	**ECTS 7,5**
2	**Courses/lectures**	a) Lecture: 2 semester hrs/week b) Practical: 2 semester hrs/week	
3	**Lecturers**	Prof. Dr. Michael Kohlhase michael.kohlhase@fau.de	
4	**Module coordinator**	Prof. Dr. Michael Kohlhase michael.kohlhase@fau.de	
5	**Content**	This course covers the foundations of Artificial Intelligence (AI), in particular symbolic techniques based on search and inference.	
6	**Learning objectives and skills**	Knowledge: - The students learn foundational representations and algorithms in AI. Application: - The concepts learned are applied to examples from the real world (homeworks). Analysis: - By modeling human cognitive abilities, students learn to assess and understand human intelligence better. Social Competences: - Students work in small groups to solve an AI game-play challenge/competition (Kalah).	
7	**Prerequisites**		
8	**Integration into curriculum**	1st semester	
9	**Module compatibility**	Mandatory elective module: - B. Sc./M. Sc. Data Science (DW, AI) - B.Sc./M. Sc. Informatik	
10	**Method of examination**	Written exam (90 min.) and completed practical exercises	
11	**Grading Procedure**	100% based on written exam	
12	**Module frequency**	Winter semester (annually)	
13	**Workload**	Contact hours: 60 hrs Independent study: 165 hrs Total: 225 hrs, corresponding to 7,5 ECTS credits	
14	**Module duration**	One semester	
15	**Teaching and examination language**	German or English (Choice of students)	
16	**Recommended reading**	- Stuart Russell & Peter Norvig: Artificial Intelligence: A Modern Approach. Prentice Hall, 3rd edition, 2009.	

1	**Module name**	**DiscOpt I: Discrete Optimization I**	**ECTS 5**
2	**Courses/lectures**	a) Lecture: 2 semester hrs/week b) Practical: 1 semester hr/week	
3	**Lecturers**	Dr. Andreas Bärmann andreas.baermann@math.uni-erlangen.de	
4	**Module coordinator**	Prof. Dr. Alexander Martin alexander.martin@fau.de	
5	**Content**	Theoretical and practical fundamentals of solving difficult mixed-integer linear optimization problems (MIPs) constitute the main focus of this lecture. At first, the concept of NP-completeness and a selection of common NP-complete problems will be presented. As for polyhedral theory, fundamentals concerning the structure of faces of convex polyhedra will be covered. Building upon these fundamentals, cutting plane algorithms as well as branch-and-cut algorithms for solving MIPs will be taught. Finally, some typical problems of discrete optimization, e.g., the knapsack problem, the traveling salesman problem or the set packing problem will be discussed.	
6	**Learning objectives and skills**	Students • will gain basic theoretical knowledge of solving mixed-integer linear optimization problems (MIPs), • are able to solve MIPs with the help of state-of-the-art optimization software.	
7	**Prerequisites**	Recommended: Linear and Combinatorial Optimization	
8	**Integration into curriculum**	1st or 3rd semester	
9	**Module compatibility**	Mandatory elective module for MSc Computational and Applied Mathematics, Elective module for MSc in Mathematics, Elective module for MSc in Mathematics and Economics, Core/research module MSc Mathematics within “Modeling, simulation, optimization”, MSc Mathematics and Economics within “Optimization and process management”	
10	**Method of examination**	Oral exam (15 minutes)	
11	**Grading Procedure**	100% based on oral exam	
12	**Module frequency**	Winter semester (not annually) To check whether the course is offered, see UnivIS: univis.fau.de	
13	**Workload**	Contact hours: 45 h Independent study: 105 h Total: 150 hrs, corresponding to 5 ECTS credits	
14	**Module duration**	One semester	
15	**Teaching and examination language**	English	

16	**Recommended reading**	Lecture notes Conforti, Cornuéjols & Zambelli: Integer Programming, Springer 2014 B. Grünbaum: Convex Polytopes, Springer, 2003 B. Korte & J. Vygen: Combinatorial Optimization, Springer 2005 G. L. Nemhauser & L.A. Wolsey: Integer and Combinatorial Optimization, Wiley 1994 A. Schrijver: Theory of Linear and Integer Programming, Wiley 1986 L.A. Wolsey: Integer Programming, Wiley 1998 G. Ziegler: Lectures on Polytopes, Springer, 1995

1	**Module name**	**IPReg: Inverse Problems and their Regularization**	**ECTS 5**
2	**Courses/lectures**	a) Lecture: 2 semester hrs/week b) Practical: 0.5 semester hrs/week	
3	**Lecturers**	Prof. Dr. Martin Burger, Dr. Philipp Wacker martin.burger@math.fau.de	
4	**Module coordinator**	Prof. Dr. Martin Burger martin.burger@math.fau.de	
5	**Content**	Examples of inverse and ill-posed problems in engineering and medical imaging Linear regularization methods in Hilbert spaces and singular value decomposition Variational methods for regularization and image reconstruction problems Tomographic reconstruction and Radon transforms	
6	**Learning objectives and skills**	Students • develop understanding for special aspects of inverse problems and ill-posedness, • apply regularization methods to inverse problems and develop a basic understanding of their properties, • derive and solve inverse problems arising from technical and biomedical applications.	
7	**Prerequisites**	Recommended: basic knowledge in functional analysis	
8	**Integration into curriculum**	1^{st} or 3^{rd} semester	
9	**Module compatibility**	Mandatory elective module for MSc in Computational and Applied Mathematics Elective module for MSc in Mathematics Elective module for MSc in Mathematics and Economics	
10	**Method of examination**	Oral exam (15 minutes)	
11	**Grading Procedure**	100% based on oral exam	
12	**Module frequency**	Winter semester (not annually) To check whether the course is offered in the current semester, see UnivIS univis.fau.de or module handbook of current semester	
13	**Workload**	Contact hours: 37,5 hrs Independent study: 112,5 hrs Total: 150 hrs, corresponding to 5 ECTS credits	
14	**Module duration**	One semester	
15	**Teaching and examination language**	English	
16	**Recommended reading**	H. Engl, M. Hanke, A. Neubauer: Regularization Methods for Inverse Problems, Kluwer 1996 M. Benning, M. Burger: Modern Regularization Methods for Inverse Problems, Acta Numerica 2018	

1	**Module name**	**MoL: Mathematics of Learning**	**ECTS 5**
2	**Courses/lectures**	a) Lecture: 2 semester hrs/week b) Practical: 2 semester hrs/week	
3	**Lecturers**	Prof. Dr. Frauke Liers	
4	**Module coordinator**	Prof. Dr. M. Burger martin.burger@fau.de	
5	**Content**	- Machine learning: empirical risk minimization, kernel methods and variational models - Mathematical aspects of deep learning - Ranking problems - Mathematical models of network interaction	
6	**Learning objectives and skills**	Students - develop understanding of modern big data and state of the art methods to analyze them, - apply state of the art algorithms to large data sets, - derive models for network / graph structured data.	
7	**Prerequisites**	Prerequisites: Basic knowledge in numerical methods and optimization is recommended.	
8	**Integration into curriculum**	1st semester	
9	**Module compatibility**	Mandatory module for: - M. Sc. Data Sciences Mandatory elective module for: - M. Sc. Computational and Applied Mathematics Elective module for: - M. Sc. Mathematics - M. Sc. Mathematics and Economics	
10	**Method of examination**	Oral exam (15 minutes)	
11	**Grading Procedure**	100% based on oral exam	
12	**Module frequency**	Module frequency Wintersemester	
13	**Workload**	Contact hours: 60 hrs Independent study: 90 hrs Total: 150 hrs, corresponding to 5 ECTS credits	
14	**Module duration**	One Semester	
15	**Teaching and examination language**	English	
16	**Recommended reading**	Courville, Goodfellow, Bengio, Deep Learning, MIT Press, 2015 Hastie, Tibshirani, Friedman, The Elements of Statistical Learning, 2008	

1	**Module name**	**Modeling, Optimization and Simulation of Energy Systems (MOSES)**	**ECTS 5**
2	**Courses/lectures**	a) Lectures: 2 semester hrs/week b) Practical: 2 semester hrs/week	
3	**Lecturers**	Prof. Dr.-Ing. Marco Pruckner marco.pruckner@fau.de	
4	**Module coordinator**	Prof. Dr.-Ing. Marco Pruckner marco.pruckner@fau.de	
5	**Content**	The lecture Modeling, Optimization and Simulation of Energy Systems deals with system-technical planning and analysis methods that are used to solve complex and interdisciplinary decision-making tasks in the energy industry. The most important methods and procedures are taught on the basis of practical issues (e.g. expansion of renewable energies, increase in electromobility) from energy policy planning and how to deal with technical-economic problems. Tools used include the statistical software R, AnyLogic and lpSolve. Previous experience with these tools is not required. Introductions to the software packages will be given in the practical lessons. Please note that this course is only available in German language!	
6	**Learning objectives and skills**	Students • distinguish problems and challenges associated with the energy transition • understand the advantages and possible applications of computer-aided planning methods in the energy sector • analyze different problems and implement solutions for them • learn various methods of data analysis, optimization and simulation	
7	**Prerequisites**	No prerequisites are necessary	
8	**Integration into curriculum**	-	
9	**Module compatibility**	-	
10	**Method of examination**	Oral examination (duration: 30 min) or written examination (if number of participants > 25)	
11	**Grading Procedure**	The module examination consists of: - Working on four assignment sheets in groups of 2-3 students. For the ungraded practice certificate, all assignment sheets must be solved correctly and handed in - Oral examination (duration: 30 min) or written examination (if number of participants > 25)	
12	**Module frequency**	Annually (winter term)	
13	**Workload**	Contact hours: 60 hrs Independent study: 90 hrs Total: 150 hrs, corresponding to 5 ECTS credits	

14	**Module duration**	Winter term
15	**Teaching and examination language**	Teaching language: German; Examination language: German or English
16	**Recommended reading**	No additional reading necessary

1	**Module name**	**Module PR: Pattern Recognition**	**ECTS 5**
2	**Courses/lectures**	a) Lectures: 3 semester hrs/week b) Practical: 1 semester hr/week	
3	**Lecturers**	Prof. Dr. Andreas Maier andreas.maier@fau.de	
4	**Module coordinator**	Prof. Dr. Andreas Maier andreas.maier@fau.de	
5	**Content**	Mathematical foundations of machine learning based on the following classification methods: - Bayesian classifier - Logistic Regression - Naive Bayes classifier - Discriminant Analysis - norms and norm dependent linear regression - Rosenblatt's Perceptron - unconstraint and constraint optimization - Support Vector Machines (SVM) - kernel methods - Expectation Maximization (EM) Algorithm and Gaussian Mixture Models (GMMs) - Independent Component Analysis (ICA) - Model Assessment - AdaBoost	
6	**Learning objectives and skills**	Students - understand the structure of machine learning systems for simple patterns - explain the mathematical foundations of selected machine learning techniques - apply classification techniques in order to solve given classification tasks - evaluate various classifiers with respect to their suitability to solve the given problem - understand solutions of classification problems and implementations of classifiers written in the programming language Python	
7	**Prerequisites**	Recommended: - Well grounded in probability calculus, linear algebra/matrix calculus - The attendance of our bachelor course 'Introduction to Pattern Recognition' is not required but certainly helpful.	
8	**Integration into curriculum**	1st semester	
9	**Module compatibility**	Mandatory elective module in: - B. Sc./M. Sc. Data Sciences (AI) - B.Sc./M. Sc. Informatik	
10	**Method of examination**	Oral exam (30 min.)	
11	**Grading Procedure**	100% based on oral exam	
12	**Module frequency**	Winter semester (anually)	
13	**Workload**	Contact hours: 60 h Independent study: 90 h Total: 150 hrs, corresponding to 5 ECTS credits	

14	**Module duration**	One semester
15	**Teaching and examination language**	English
16	**Recommended reading**	- Richard O. Duda, Peter E. Hart, David G. Stock: Pattern Classification, 2nd edition, John Wiley&Sons, New York, 2001 - Trevor Hastie, Robert Tobshirani, Jerome Friedman: The Elements of Statistical Learning - Data Mining, Inference, and Prediction, 2nd edition, Springer, New York, 2009 - Christopher M. Bishop: Pattern Recognition and Machine Learning, Springer, New York, 2006

1	**Module name**	**Module SaM1: Simulation and Modeling 1**	**ECTS 5**
2	**Courses/lectures**	a) Lectures: 2 semester hrs/week b) Practical: 2 semester hrs/week	
3	**Lecturers**	Prof. Dr.-Ing. Reinhard German reinhard.german@fau.de	
4	**Module coordinator**	Prof. Dr.-Ing. Reinhard German reinhard.german@fau.de	
5	**Content**	- Overview of the various kinds of simulation - discrete simulation (computational concepts, simulation of queuing systems, simulation in Java, professional simulation tools) - required probability concepts and statistics, modeling paradigms (e.g., event/process oriented, queuing systems, Petri nets, UML statecharts) - input modeling (selecting input probability distributions) - random number generation (linear congruential generators and variants, generating random variates) - output analysis (warm-up period detection, independent replications, result presentation) - continuous and hybrid simulation (differential equations, numerical solution, hybrid statecharts) - simulation software, case studies, parallel and distributed simulation.	
6	**Learning objectives and skills**	Students - gain knowledge about methods and realization possibilities of discrete simulation with an outlook on other types of simulation - gain knowledge of statistical aspects of simulation that are important for practice - apply statistical methods for analysis and evaluation of input and output data - gain hands-on experience with commercial simulation tools - gain experience in simulation in various fields of application (including computer networks, manufacturing systems, material flow systems) - independently develop simulation models on the basis of sample tasks using different modeling paradigms - can work in groups cooperatively and responsibly	
7	**Prerequisites**	Recommended: - basic programming knowledge, ideally in Java - Mathematical knowledge in calculus	
8	**Integration into curriculum**	1st semester	
9	**Module compatibility**	Mandatory elective module in: - B. Sc./M. Sc. Data Sciences (SN) - B.Sc. Informatik	
10	**Method of examination**	Written exam (90 min.) or oral exam (30 min.) (ungraded)	
11	**Grading Procedure**	100% based on written / oral exam	
12	**Module frequency**	Winter semester (anually)	
13	**Workload**	Contact hours: 60 h Independent study: 90 h Total: 150 hrs, corresponding to 5 ECTS credits	
14	**Module duration**	One Semester	

15	**Teaching and examination language**	Englisch
16	**Recommended reading**	Averill Law: Simulation, Modeling and Analysis, 5th Edition, McGraw-Hill, 2014. J. Banks, J. Carson, B. Nelson, D. Nicol: Discrete-Event System Simulation, 5th Edition, Prentice Hall, 2009. J. Banks: Getting started with AutoMod, 2nd Edition, Autosimulations Inc., 2000.

1	**Module name**	**Module SaSC1: Simulation and Scientific Computing 1**	**ECTS 7,5**
2	**Courses/lectures**	Simulation und Wissenschaftliches Rechnen 1 (V) 2 SWS Übungen zu Simulation und Wissenschaftliches Rechnen 1 (Ü) 2 SWS Tutorium zu Simulation und Wissenschaftliches Rechnen 1 (T) 2 SWS	
3	**Lecturers**	Prof. Dr. Christoph Pflaum christoph.pflaum@fau.de	
4	**Module coordinator**	Prof. Dr. Christoph Pflaum christoph.pflaum@fau.de	
5	**Content**	- performance Optimization of numerical algorithms. - parallelization by OpenMP - spatial finite difference discretization - practical estimation of the discretization error and the convergence rate of numerical methods - software development in scientific computing - parallelization by MPI - finite difference discretization in time	
6	**Learning objectives and skills**	Students learn - techniques for optimizing algorithms in the field of scientific computing - to implement and optimize algorithms on parallel computers - to analyze the stability of numerical algorithms	
	Prerequisites	Recommendation: - a modul in the area of numerical mathematics	
8	**Integration into curriculum**	1. Semester	
9	**Module compatibility**	Wahlpflichtmodul in: - B. Sc./M. Sc. Data Sciences (SN) - M. Sc. Informatik Pflichtmodul: - Bachelor Computational Engineering	
10	**Method of examination**	Klausur (90 min.) und unbenotete Übungsleistung	
11	**Grading Procedure**	Klausur 100%	
12	**Module frequency**	1 x jährlich jeweils im WiSe	
13	**Workload**	Präsenzzeit: 90 h Eigenstudium: 135 h	
14	**Module duration**	1 Semester	
15	**Teaching and examination language**	Deutsch oder Englisch (nach Wahl der Studierenden)	

16	**Recommended reading**	- Lehrbuch: G. Hager und G. Wellein, Introduction to High Performance Computing for Scientists and Engineers, CRC Press, 2010. - Lehrbuch: Goedecker und Adolfy Hoisie. Performance Optimization of Numerically Intensive Codes, SIAM, 2001. - Lehrbuch: Gropp, Lusk, Skjellum, Using MPI. The MIT Press, 1999. - Lehrbuch: Alexandrescu, Modern C++ Design, Generic Programming and Design Patterns. Addison-Wesley, 2001. - Lehrbuch: Burden, Faires, Numerical Analysis, Brooks, 2001. - Lehrbuch: Chandra at. al., Programming in OpenMP, Academic Press, 2001.

Deutsche Module

1	**Modulbezeichnung**	**Module eBTuEI: eBusiness Technologies und Evolutionäre Informationssysteme** (englische Bezeichnung: eBusiness Technologies and Evolutionary Information Systems)	**ECTS 5**
2	**Lehrveranstaltungen**	a) Vorlesung eBusiness Technologies: 2 SWS b) Vorlesung Evolutionäre Informationssysteme: 2 SWS	
3	**Lehrende**	Prof. Dr. Richard Lenz richard.lenz@fau.de Dr. Christoph P. Neumann cpnatwork@googlemail.com Dr. Florian Irmert florian.irmert@fau.de	
4	**Modulverantwortung**	Prof. Dr. Richard Lenz richard.lenz@fau.de	
5	**Inhalt**	E-Business Technologies: Überblick und Einblick in die wichtigsten Themen des Bereichs eBusiness: Von den Anwendungen bis zu den Implementierungen - Vorgehen: Klassifikation, Ordnung von Techniken und Methoden; Bewertung - Einführung: eBusiness als Anwendung, Definition der Integration, B2B Integration, Realisierung von eBusiness-Anwendungen (WAA, WPA) - Architektur: Grundlagen des Webs, HTTP-/Web-/Application Server - Implementierung: Markup Languages (HTML, XML), Enterprise Java Beans, J2EE, DB-Zugriffstechniken, Web Services Evolutionäre Informationssysteme: Im Rahmen der Veranstaltung EIS lernen die Studenten, warum und wie mit einem ständig wechselnden Bedarf in Informationssystemen umgegangen werden kann. Die Inhalte der Vorlesung sind u.A.: - Grundlagen rechnergestützter Informationssysteme und organisatorisches Lernen - Erfolgsfaktoren für Projekte - Software Wartung vs. Software Evolution - Architekturmodelle - Grundprinzipien evolutionärer Systeme Datenqualität in Informationssystemen	

6	**Lernziele und Kompetenzen**	EBT: Die Studierenden - identifizieren die wichtigsten Themen des Bereichs eBusiness, von den Anwendungen bis zu den Implementierungen - verstehen Zusammenhänge der B2B-Integration und der Realisierung von eBusiness-Anwendungen - wiederholen Grundlagen des Webs - vergleichen technische Eigenschaften von HTTP-, Web- und Application Servern - vergleichen Markup Languages (HTML, XML) - unterscheiden Ansätze zur Schema-Modellierung wie DTD und XML Schema und erkennen die unterschiedliche Leistungsfähigkeit - verstehen Methoden zur evolutionsfähigen Gestaltung von Datenstrukturen in XML - unterscheiden Vorgehen bei der Datenhaltung und verschiedene Ansätze für den Datenbankzugriff - verstehen Objekt-relationale Mapping Frameworks am Beispiel von Hibernate und JPA - verstehen Komponentenmodelle wie Enterprise JavaBeans (EJB) aus dem JEE Framework - unterscheiden das EJB Komponentenmodell von den OSGi Bundles und den Spring Beans - verstehen und unterscheiden grundlegende Web Service Techniken wie SOAP und WSDL - unterscheiden Herangehensweisen zur dynamischen Generierung von Webseiten - verstehen grundlegende Eigenschaften eines Java-basierten Front-End-Frameworks am Beispiel von JSF - verstehen grundlegende Eigenschaften von Service-orientierten Architekturen (SOA) - verstehen agile Vorgehensmodelle zur Software-Entwicklung am Beispiel von Scrum - unterscheiden agile Verfahren wie Scrum von iterativ-inkerementellen Verfahren wie RUP - verstehen die Wichtigkeit von Code-Beispielen um die praktische Anwendbarkeit des theoretischen Wissens zu veranschaulichen. - können die Code-Beispiele eigenständig zur Ausführung bringen und die praktischen Erfahrungen interpretieren und bewerten - gestalten eigene Lernprozesse selbständig. - schätzen ihre eigenen Stärken und Schwächen im Hinblick auf die unterschiedlichen Architektur-Schichten ein(Benutzerinteraktion, Applikationslogik, Schnittstellenintegration, Datenbanksysteme) - identifizieren eine eigene Vorstellung als zukünftige Software-Architekten und können die eigene Entwicklung planen - reflektieren durch regelmäßige fachbezogene Fragen des Lehrende Ihre eigene Lösungskompetenz. EIS: Die Studierenden: - definieren die Begriffe "Informationssysteme", "evolutionäre Informationssyste" und "organisatorisches Lernen" - grenzen die Begriffe "Wissen" und "Information" gegeneinander ab - charakterisieren die in der Vorlesung erläuterten Formen der organisatorischen Veränderung - erklären das SEKI Modell nach Nonaka und Takeuchi - nennen Beispiele für die in der Vorlesung behandelten Formen der Wissensrepräsentation in IT-Systemen - nennen typische Erfolgs- und Risikofaktoren für große IT-Projekte - erklären die Kraftfeldtheorie nach Kurt Lewin

		- unterscheiden Typen von Software gemäß der Klassifikation nach Lehman und Belady - unterscheiden die in der Vorlesung vorgestellten Arten der Software Wartung - benennen die Gesetzmäßigkeiten der Software-Evolution nach Lehman und Belady - bewerten die in der Vorlesung vorgestellten Vorgehensmodelle zur Softwareerstellung im Kontext der E-Typ-Software - nennen die in der Vorlesung vorgestellten Aspekte der Evolutionsfähigkeit von Software - erklären, wie die in der Vorlesung vorgestellten Methoden zur Trennung von Belangen beitragen - erklären das Konzept des "Verzögerten Entwurfs" - erklären die Vor- und Nachteile generischer Datenbankschemata am Beispiel von EAV und EAV/CR - charakterisieren die in der Vorlesung vorgestellten Architekurkonzepte - grenzen die in der Vorlesung vorgestellten Integrationsanforderungen gegeneinander ab - erklären wie Standards zur Systemintegration beitragen und wo die Grenzen der Standardisierung liegen - erklären das Prinzip eines Kommunikationsservers und der nachrichtenbasierten Integration - erklären den Begriff "Prozessintegration" - definieren den Begriff "Enterprise Application Integration" (EAI) - unterscheiden die in der Vorlesung vorgestellten Integrationsansätze - erklären die in der Vorlesung vorgestellten Dimensionen der Datenqualität - unterscheiden die grundlegenden Messmethoden für Datenqualität - erklären das Maßnahmenportfolio zur Verbesserung der Datenqualität nach Redman benennen die in der Vorlesung vorgestellten Methoden zur Verbesserung der Datenqualität
7	**Voraussetzungen für die Teilnahme**	Dringend empfohlen: - Programmieren in Java, Datenbanken (SQL) Empfohlen: Konzeptionelle Modellierung
8	**Einpassung in Musterstudienplan**	Ab 1. Semester
9	**Verwendbarkeit des Moduls**	Wahlpflichtmodul in: - B. Sc./M. Sc. Data Sciences (DW) • - B.Sc./M. Sc. Informatik
10	**Studien- und Prüfungsleistung**	mündliche Prüfung (30 min.)
11	**Berechnung Modulnote**	mündliche Prüfung 100%
12	**Turnus des Angebots**	1 x jährlich jeweils im WiSe
13	**Arbeitsaufwand**	Präsenzzeit: 60 h • Eigenstudium: 90 h
14	**Dauer des Moduls**	1 Semester
15	**Unterrichts- und Prüfungssprache**	Deutsch

16	**Literaturhinweise**	E-Business Technologies: - Michael Merz: E-Commerce und E-Business. 2. Aufl. Dpunkt Verlag, 2002 - Craig Larman: Applying UML and Patterns. 3rd ed. Prentice Hall, 2004 - Dan Pilone, Russ Miles: Head First Software Development. 1. Aufl. O'Reilly Media, 2007 - Rod Johnson: Expert One-on-one J2EE Design and Development. Wiley & Sons, 2003 - Bernd Müller: JBoss Seam. 1. Aufl. Hanser Fachbuch, 2007 • Craig Walls, Ryan Breidenbach: Spring in Action. 2. Aufl. Manning Publications, 2007

1	**Modulbezeichnung**	**Modul PDG I: Partielle Differentialgleichungen I** (englische Bezeichnung: Partial Differential Equations I)	**ECTS 10**
2	**Lehrveranstaltungen**	a) Vorlesung: 4 SWS b) Übung: 2 SWS	
3	**Lehrende**	1. Prof. Dr. Martin Burger martin.burger@math.fau.de 2. Dr. Cornelia Schneider cornelia.schneider@math.fau.de	
4	**Modulverantwortung**	Prof. Dr. Günther Grün gruen@math.fau.de	
5	**Inhalt**	• schwache Existenztheorie elliptischer Gleichungen zweiter Ordnung • Regularität schwacher Lösungen (Differenzenquotientenmethode, Moser, Harnack) • Wärmeleitungsgleichung in Hölderräumen, Vergleichssätze Die Präsentation des Stoffes erfolgt in Vorlesungsform. Die weitere Aneignung der wesentlichen Begriffe und Techniken erfolgt durch wöchentliche Hausaufgaben.	
6	**Lernziele und Kompetenzen**	Die Studierenden erarbeiten sich einen Überblick über Anwendungsbereiche von PDGen. Sie verwenden einfache explizite Lösungsmethoden und nutzen klassische und „schwache" Zugänge zu Existenzresultaten	
7	**Voraussetzungen für die Teilnahme**	empfohlen: Analysis-Module des Bachelorstudiums	
8	**Einpassung in Musterstudienplan**	Semester 5 oder 6	
9	**Verwendbarkeit des Moduls**	Wahlpflichtmodul in • B.Sc. Bachelor Mathematik (Theoretische Mathematik, Angewandte Mathematik) • B.Sc. Technomathematik (Numerische Mathematik, Modellierung und Optimierung) • B.Sc. Wirtschaftsmathematik (Mathematische Wahlpflichtmodule) • M.Sc. Mathematik (Studienrichtung „Analysis und Stochastik", „Modellierung, Simulation und Optimierung") • M.Sc. Technomathematik (Studienrichung „Modellierung und Simulation") • M.Sc. Wirtschaftsmathematik (Mathematische Wahlpflichtmodule)	
10	**Studien- und Prüfungsleistung**	mündliche Prüfung (20 Min.)	
11	**Berechnung Modulnote**	mündliche Prüfung (100 %)	
12	**Turnus des Angebots**	jährlich im Wintersemester	
13	**Arbeitsaufwand**	Workload 300 h davon • Vorlesung: 4 SWS x 15 = 60 h • Übung: 2 SWS x 15 = 30 h • Selbststudium: 210 h	

14	**Dauer des Moduls**	ein Semester
15	**Unterrichts- und Prüfungssprache**	deutsch
16	**Literaturhinweise**	• E. DiBenedetto: Partial Differential Equations, Birkhäuser 2001 • L. C. Evans: Partial Differential Equations, AMS 1997 • D. Gilbarg, N. S. Trudinger: Elliptic Partial Differential Equations, Springer 1983 • Vorlesungsskriptum