Prüfungsordnung des Fachbereichs 2: Informatik und Ingenieurwissenschaften – Computer Science and Engineering der Fachhochschule Frankfurt am Main – University of Applied Sciences für den Master Studiengang High Integrity Systems vom 13. Dezember 2006

Aufgrund des § 50 Abs. 1 Nr. 1 des Hessischen Hochschulgesetzes (HHG) in der Fassung vom 31. Juli 2000 (GVB1. I S. 374), zuletzt geändert durch Gesetz vom 15. Dezember 2005 (GVB1. I S. 843), hat der Fachbereichsrat des Fachbereichs 2: Informatik und Ingenieurwissenschaften – Computer Science and Engineering der Fachhochschule Frankfurt am Main – University of Applied Sciences am 13. Dezember 2006 die nachstehende Prüfungsordnung für den Master-Studiengang High Integrity Systems beschlossen. Die Prüfungsordnung entspricht den Allgemeinen Bestimmungen für Prüfungsordnungen mit den Abschlüssen Bachelor und Master an der Fachhochschule Frankfurt am Main – University of Applied Sciences (AB Bachelor/Master) vom 10. November 2004 (Staatsanzeiger für das Land Hessen 2005 S. 519) und ergänzt die Allgemeinen Bestimmungen.
Nach § 94 Abs. 4 HHG hat der Präsident der Fachhochschule Frankfurt am Main – University of Applied Sciences die Prüfungsordnung am 15. März 2007 genehmigt. Die Genehmigung ist befristet für die Dauer der Akkreditierung bis zum 31. August 2012.

§ 1 Studienziel, akademischer Grad

(1) Das Studium qualifiziert für eine selbstständige forschungs-, entwicklungsorientierte berufliche Tätigkeit in der Informatik.
(2) Nach der bestandenen Masterprüfung verleiht die Fachhochschule Frankfurt am Main – University of Applied Sciences den akademischen Grad Master of Science.
(3) Der Master-Studiengang ist als konsekutiver und anwendungsorientierter Studiengang konzipiert. Näheres ergibt sich aus dem Diploma Supplement.

§ 2 Regelstudienzeit, ECTS-Punkte (Credits)

(1) Die Regelstudienzeit beträgt 4 Semester.
(2) Das gesamte Studium umfasst 120 ECTS-Punkte (Credits).

§ 3 Zulassung

Für den Zugang und das Zugangsverfahren gilt die Zulassungsordnung (siehe Anlage 1).

§ 4 ECTS-Punkte (Credits) und Module

(1) Der Studiengang umfasst 18 Module. Die Inhalte der Module, die Anzahl der jeweiligen ECTS-Punkte (Credits) sowie die jeweiligen Prüfungsleistungen ergeben sich aus den Modulbeschreibungen (Anlage 3).
(2) Die Voraussetzungen für die Zulassung zu einer Modulprüfung sind in der jeweiligen Modulbeschreibung geregelt (Anlage 3).
(3) Die Module werden in englischer Sprache durchgeführt.

§ 5 Art der Prüfungsleistungen

(1) Die Art der Modulprüfungsleistung oder Modulteilprüfungsleistung ist in der jeweiligen Modulbeschreibung geregelt.

(2) Die Modulprüfungen in den Modulen werden in englischer Sprache durchgeführt. Auf Antrag des Studierenden können Modulprüfungen nach Beschluss des Prüfungsausschusses in deutscher Sprache durchgeführt werden.
(3) Die Bearbeitungszeit einer schriftlichen Prüfungsleistung in Form von Klausurarbeiten beträgt mindestens 90 Minuten und höchstens 180 Minuten. Die Dauer der schriftlichen Prüfungsleistungen in den einzelnen Modulen ist in den Modulbeschreibungen geregelt (Anlage 1).
(4) Das Modul 17: Project umfasst 10 ECTS-Punkte (Credits). Die Dauer beträgt 18 Wochen.

§ 6 Wiederholung von Prüfungsleistungen

(1) Nicht bestandene Modulprüfungsleistungen oder Modulteilprüfungsleistungen können zweimal wiederholt werden.
(2) Der Prüfungsausschuss legt Wiederholungsfristen fest.

§ 7 Master-Arbeit

(1) Die Master-Arbeit umfasst 30 ECTS-Punkte (Credits). Die Zeit von der Ausgabe der Master-Arbeit bis zur Abgabe der Master-Arbeit beträgt 6 Monate.
(2) Für die Zulassung zur Master-Arbeit müssen die Module 1 bis einschließlich 17 erfolgreich abgeschlossen sein.
(3) Die Master-Arbeit ist in schriftlicher Form fristgerecht beim Prüfungsamt des Fachbereichs 2 in zwei gebundenen Ausfertigungen einzureichen. Teile der Master-Arbeit, die als Quellprogrammdateien oder ausführbare Dateien oder sonstige Dateien vorliegen, sind auf einem zeitgemäßen Medium beizufügen. Das Abgabedatum wird aktenkundig gemacht.
(4) Kann der Abgabetermin aus Gründen, die die Studierende oder der Studierende nicht zu vertreten hat, nicht eingehalten werden, so verlängert der Prüfungsausschuss einmal die Bearbeitungszeit, wenn die Studierende oder der Studierende dies vor dem Abgabetermin beantragt und die Betreuerin oder der Betreuer zustimmt. Der Prüfungsausschuss kann die Bearbeitungszeit um die Dauer der Verhinderung, höchstens jedoch um sechs Wochen verlängern. Ist dann eine fristgerechte Abgabe nicht möglich, wird ein neues Thema ausgegeben, wobei das vorhergehende Thema als nicht ausgegeben gewertet wird.
(5) Die Master-Arbeit ist in englischer Sprache abzufassen.
(6) Bei unterschiedlicher Bewertung der Master-Arbeit wird von der Vorsitzenden oder dem Vorsitzenden des Prüfungsausschusses die Note aus dem arithmetischem Mittel der Einzelnoten gebildet. Der Prüfungsausschuss holt die Stellungnahme einer dritten Prüferin oder eines dritten Prüfers ein, wenn die Beurteilungen der Prüfenden um mehr als 2,0 voneinander abweichen oder wenn eine oder einer der Prüferenden die Master-Arbeit als "nicht ausreichend" beurteilt. Die Note wird in diesem Fall aus den Noten der Erstprüferin oder des Erstprüfers, der Zweitprüferin oder des Zweitprüfers und der Drittprüferin oder des Drittprüfers aus dem arithmetischem Mittel der Einzelnoten gebildet.
(7) Die Master-Arbeit ist im Rahmen eines Kolloquiums vorzustellen. Das Kolloquium findet innerhalb von 4 Wochen nach Bestehen der Master-Arbeit statt. Die Dauer des Kolloquiums beträgt mindestens 30 Minuten und maximal 60 Minuten.
(8) Die Note des Moduls Master-Arbeit setzt sich aus den Noten der Master-Arbeit und des Kolloquium im Verhältnis 7:3 zusammen.

§ 8 Gesamtnote

(1) Für das Master-Zeugnis wird eine Gesamtnote gebildet. Die Gesamtnote der Master-Prüfung errechnet sich aus dem entsprechend der ECTS-Punkte (Credits) gewichteten Mittel der Noten der Modulprüfungen.

(2) Für die Gesamtnote wird ein ECTS-Rang vergeben.

§ 9 In-Kraft-Treten

Die Prüfungsordnung tritt am 01. September 2006 (Wintersemester 2006/07) in Kraft.

Frankfurt am Main, 16. März 2007

gez. Prof. Dr. Michael Hefter
Dekan des Fachbereichs 2: Informatik und Ingenieurwissenschaften,
Computer Science and Engineering

Anlage 1:

Zulassungsordnung

Master-Studiengang High Integrity Systems

§ 1 Zulassungsvoraussetzungen

(1) Zugangsberechtigt zum Master-Studiengang High Integrity Systems sind Absolventinnen und Absolventen eines mindestens sechssemestrigen Hochschulstudiums mit den Abschlüssen Bachelor oder Diplom in der Fachrichtung Informatik oder in einem anderen geeigneten Studiengang.

(2) Geeignete Studiengänge sind Studiengänge mit einem Informatikanteil von mindestens 60% aller in dem Studiengang möglichen ECTS-Punkte. Die Feststellung geeigneter Studiengänge trifft der Prüfungsausschuss.

(3) Voraussetzung für die Zulassung ist ein überdurchschnittlicher Abschluss des Hochschulstudiums sowie der Nachweis guter Kenntnisse der englischen Sprache in Wort und Schrift.

§ 2 Überprüfung der Eignung

(1) Zur Überprüfung der Eignung sind Zeugnisse und Leistungsbeurteilungen einzureichen, die das Vorliegen der Voraussetzungen nach § 1 erkennen lassen. In Zweifelsfällen kann ein Bewerbungsgespräch verlangt werden.

(2) Ein überdurchschnittlicher Abschluss eines Hochschulstudiums gilt als nachgewiesen, wenn die Gesamtnote mindestens 2,0 ist.

(3) Gute Kenntnisse der englischen Sprache in Wort und Schrift sind nachzuweisen. Von dem Nachweis dieser Sprachtests sind Bewerberinnen und Bewerber mit ausländischen Vorbildungsnachweisen entbunden, falls ihre Muttersprache Englisch ist. Ebenso sind Absolventinnen und Absolventen englischsprachiger Studiengänge oder deutscher Studiengänge mit englischsprachlichem Anteil von mindestens 30 Credit-Points von dem Nachweis befreit.

§ 3 Zulassungsverfahren

(1) Bewerberinnen und Bewerber, welche die erforderliche Eignung nach § 2 nachweisen und die nach § 4 Abs. (2) erforderlichen Bewerbungsunterlagen eingereicht haben, werden zugelassen.

(2) Nach Maßgabe freier Studienplätze können auf Vorschlag des Prüfungsausschusses weitere Bewerberinnen und Bewerber mit einer Gesamtnote zwischen 2,0 und 2,5zugelassen werden.

§ 4 Bewerbungsverfahren

(1) Das Masterstudium beginnt jeweils im Wintersemester. Bewerbungen sind bis zum 15. September eines jeden Jahres bzw. für Bewerber mit ausländischen Vorbildungsnachweisen bis zum 15. April eines jeden Jahres unter Beifügung der in Abs. 2 genannten Unterlagen zu richten an:

Fachhochschule Frankfurt am Main
University of Applied Sciences
Der Präsident
Nibelungenplatz 1
60318 Frankfurt am Main

(2) Der Bewerbung sind folgende Unterlagen beizufügen:
- Formgerechte Zeugnisnachweise, aus denen hervorgeht, dass die Zulassungsvoraussetzungen nach §§ 1 und 2 erfüllt sind.
- das Curriculum Vitae,
- ein Bewerbungsschreiben, in dem dargelegt wird, worin das besondere Interesse am Master-Studium High Integrity Systems besteht und wo die eigene Qualifikation für diesen Studiengang gesehen wird.

Anlage 2: Modulübersicht

Sem	No	Modules	UNIT	Type	Form	Weekly hours	CP	Work-load
1	1	Safety Critical Computer Systems		PL	O	4	5	150
			Lectures Exercises					
	2	Advanced Formal Modeling		PL	W			
			Lectures Exercises	VL	B			
	3	Introductory Data Analysis		PL	W	4	5	150
			Lectures Exercises	VL	B			
	4	Human Machine Interface Design for SCS		PL	P	4	5	150
			Group Project					
	5	Implementation of DBMS		PL	W	4	5	150
			Lectures Exercises					
	6	Distributed Systems		PL	W	4	5	150
			Lectures Exercises					
		Sum 1. Semester				**24**	**30**	**900**
2	7	Data Mining Methods		PL	W	4	5	150
			Lectures Exercises	VL	B			
	8	Advanced IT-Security		PL	O	4	5	150
			Lectures Exercises					
	9	Advanced Testing Methods		PL	P	4	5	150
			Lectures Exercises					
	10	Standards and Certification		PL	P	2	5	150
			Seminar					
	11	System Theory and Modeling		PL	W	4	5	150
			Lectures Exercises	VL	B			
	12	Transaction Management		PL	W	4	5	150
			Lectures Exercises					
		Sum 2. Semester				**22**	**30**	**900**
3	13	Multivariate Data Analysis		PL	W	4	5	150
			Lectures Exercises	VL	B			
	14	Pattern Oriented Software Architecture		PL	O	4	5	150
			Lectures Exercises					
	15	Formal Specification and Verification		PL	W	4	5	150
			Lectures Exercises	VL	B			
	16	Simulation Methods		PL	W	4	5	150
			Lectures Exercises	VL	B			
	17	HIS Project		PL	P	6	10	300
			Group Project					
		Sum 3. Semester				**22**	**30**	**900**
4	18	Master Thesis		PL	T		30	900
			Thesis Project					
		Sum 4. Semester					**30**	**900**

Legend:

- Type of examination: VL = Prerequisite test for final examination at the end of the semester, PL = final examination
- Form of examination: W = written examination, O = oral examination, P = project, T = thesis, B = passing of all offered tests (prerequisite examination)

Anlage 3: Modulbeschreibungen

1.Module: Safety Critical Computer Systems	
Study program	M.Sc. High-Integrity Systems
Code	
Applicability	Applicable in other computer science master curricula
Semester	1
Duration	1 Semester
Credits	5 CP
Preconditions for module participation	None; recommended prerequisites: good knowledge in software engineering philosophies and methods, good programming skills in high-level programming languages
Requirements for module examination	None
Module examination	oral examination of at least 15 and maximum 45 minutes duration at the end of the semester
Status	Required module
Education goals/ capabilities	Upon completion of this course, the student is able to: distinguish between reliability and safety, critically read accident reports, perform a hazard analysis on a computer-based system, write requirements for a safety-critical system and trace safety constraints to design, work with human factors experts in the design of safe human-computer interaction, apply the principles of safe design to both systems and software, criticize and evaluate a system design for safety, and design a process for building a safety-critical system, distinguish between the role of practitioners and managers. Training for non-specialist competencies: Students learn • to search for, read, summarize and cite scientific literature. • to use modern e-learning tools. • to organize in teams to work on small projects. • to write a report as a scientific paper.
Contents	• Introduction into principles of system safety • Safety Critical Systems (SCS) with increasing software content • Terminology • Safety criteria • Hazards analysis • Risk analysis • Risk classification scheme • Safety integrity levels (SIL) • Ethical considerations, risk tolerance levels • Development of safety critical systems • System and Software Engineering Best Practices • SCS requirements analysis • SCS design goals • Fault tolerance • System reliability

Units	Lectures and exercises
Total workload (h)	150; 60 for training in non-specialist competencies
Language	English
Module frequency	Winter semester

2. Advanced Formal Modeling	
Study program	M.Sc. High-Integrity Systems
Code	
Applicability	Applicable in other computer science master curricula
Semester	1
Duration	1 Semester
Credits	5 CP
Preconditions for module participation	None
Requirements for module examination	Successful participation in unit exercises
Module examination	Written examination of 90 minutes duration at the end of the semester
Status	Required module
Education goals/ capabilities	After completing this module the students are able of • understanding the mathematical background and the theoretical foundations of formal methods in those software engineering processes, which are relevant for the design and realization of safety critical systems. • assessing the need for zero-defect software in safety critical systems. • distinguishing the basic formal specification methods. • studying advanced formal specification and verification methods.
Contents	• A short presentation of the different branches of logic: model theory, proof theory, axiomatic set theory, type theory and computability theory. • Hoare Logic, by which the correctness of imperative programs using formal assertions is proved. These ideas, which are mainly due to Floyd, Hoare and Dijkstra, have an influence on all other techniques. • A review of classical logic (propositional logic, first-order predicate logic and higher-order logics) • Set-theoretic specifications: the Z notation, VDM and the B- Method • Set theory including the Zermelo-Fraenkel Axiomatic System, induction, abstract data types and polymorphism • An introduction to proof theory including the essential concepts for understanding computer-aided proof systems. A discussion of the Dijkstra-Scholten System. This part serves also as a foundation for typing systems and computational aspects of logic. • A presentation of the algebraic approach to formal methods with abstract data types • More type Theory, the -calculus and constructive logics • An implementation of the principles of the last parts using type theory
Units	Lectures and exercises
Total workload (h)	150
Language	English
Module frequency	Winter Semester

3. Module: Introductory Data Analysis	
Study program	M.Sc. High-Integrity Systems
Code	
Applicability	Applicable in other computer science and engineering master curricula
Semester	1
Duration	1 Semester
Credits	5 CP
Preconditions for module participation	None; recommended prerequisites: good knowledge in mathematical foundations, probability theory and statistics, programming with C, C, theoretical basics of computer science, networks, operating systems
Requirements for module examination	Successful participation in the unit exercises
Module examination	Written examination of 90 minutes duration at the end of the semester
Status	Required module
Education goals/ capabilities	Upon completion of this course, the student is able to: • get an overview of typical topics in data analysis and data visualisation in typical areas of the natural sciences and medicine, • gain experience in the application of data analysis methods and procedures, • assess the information content and quality of data with respect to requirements, and • provide verified data for HIS - applications.
Contents	• Measuring data, scaling types, information content • Introductory statistical modeling • Statistical indicators • Univariate statistical methods and tests • Bivariate methods (correlation, regression) • Handling of categorized data, GLM • Classification schemes and decision trees (CART, CHAID, SVM, PLS-CA) • Neuronal networks and multivariate data analysis
Units	Lectures and exercises
Total workload (h)	150
Language	English
Module frequency	Winter semester

4. Module: Human Machine Interface Design for Safety Critical Systems	
Study program	M.Sc. High-Integrity Systems
Code	
Applicability	Applicable in other computer science master curricula
Semester	1
Duration	1 Semester
Credits	5 CP
Preconditions for module participation	None; recommended prerequisites: good knowledge in software engineering, very good programming skills in procedural and object-oriented programming languages
Requirements for module examination	None

Module examination	Written report and oral presentation
Status	Required module
Education goals/ capabilities	Upon completion of this course, the student is able to: • understand the growing importance of human machine interfaces (HMI) in SCS, • gain the capabilities to analyze HMI requirements, • to communicate with specialists of other fields to understand the requirements, • select and apply proper tools for the design and implementation of HMI in SCS. Training for non-specialist competencies: Students learn • to organize a research team; • to use modern tools for project organization; • to do research in social and psychological contexts; • to write a report as a scientific paper.
Contents	• Psychological aspects of human - computer interaction • Analysis of HMI user requirements • Analysis of human operator errors • HMI design and implementation process • HMI design based on hazard analysis • HMI design principles • HMI prototyping • HMI evaluation • HMI implementation examples • HMI validation & verification • HMI usability tests • HMI documentation and training issues
Units	Project
Total workload (h)	150; 75 for training in non-specialist competencies
Language	English
Module frequency	Winter semester

5. Module: Implementation of DBMS	
Study program	M.Sc. High-Integrity Systems
Code	
Applicability	Applicable in other computer science master curricula
Semester	1
Duration	1 Semester
Credits	5 CP
Preconditions for module participation	None, recommended prerequisites: good knowledge in use of database systems, data modeling, database inquiries and programming skills in higher programming languages.
Requirements for module examination	None

Module examination	Written examination of 90 minutes duration at the end of the semester
Status	Required module
Education goals/ capabilities	Upon completion of this course, the student is able to: • understand, why databases form the backbone of every modern information system, and why a robust database management system (DBMS) is crucial for these systems. • decide, which architectures and implementation issues are relevant for robust DBMS. comprehend prerequisites for building and extending a DBMS as well as for building the DBMS part of a larger application in a robust fashion. • assess the role of the different parameters of commercial DBMS and thus, tune these parameters in a way that results in a robust and performant system.
Contents	• DBMS architectures • DBMS memory management • Buffer management • Indexing procedures • Inquiry analysis and optimization • Interaction between data and transaction management • Performance assessment • Tuning and self-tuning of DBMS • Database technologies for object oriented and XML- based DBMS
Units	Lectures and exercises
Total workload (h)	150
Language	English
Module frequency	Winter semester

6. Module: Distributed Systems	
Study program	M.Sc. High-Integrity Systems
Code	
Applicability	Applicable in other computer science master curricula
Semester	1
Duration	1 Semester
Credits	5 CP
Preconditions for module participation	None; recommended prerequisites: good knowledge in network technologies and distributed systems
Requirements for module examination	None
Module examination	Written examination of 90 minutes duration at the end of the semester
Status	Required module
Education goals/ capabilities	Upon completion of this course, the student is able to: • understand, how complex systems that extend across different computing systems, communicate with each other, e.g. via messages. • understand, why many systems are distributed, either because their distributed nature is inherent, e.g., the Internet or because a distributed approach is chosen on purpose to improve certain system properties, e.g., the performance. • assess the mixed effects of distribution with respect to robustness. • discuss, why distribution can itself be a source of errors as the function-

	ality of the overall system relies on multiple individual systems and communication channels. understand, why a bad system design might result in a failure of a single component rendering the overall system unusable. • comprehend that distribution gives a chance for improving the resilience of the system, e.g., other nodes can take over the functionality of failing nodes much easier than in a centralized system or data can be replicated among different nodes for improving their availability.
Contents	• Characteristics of distributed systems • Middleware for distributed systems • Fault tolerance • Load balancing • Replication • Distributed file systems • Name services • Distributed algorithms
Units	Lectures and exercises
Total workload (h)	150
Language	English
Module frequency	Winter semester

7. Module: Data Mining Methods	
Study program	M.Sc. High-Integrity Systems
Code	
Applicability	Applicable in other computer science and engineering master curricula
Semester	2
Duration	1 Semester
Credits	5 CP
Preconditions for module participation	None; recommended prerequisites: modul „Introductory Data Analysis“ and good knowledge in programming with high-level programming languages
Requirements for module examination	Successful participation in unit exercises
Module examination	Written examination of 90 minutes duration at the end of the semester
Status	Required module
Education goals/ capabilities	Upon completion of this course, the student is able to: • apply the data mining methods in a scientific or medical context • for the solution of real- world problems. • assess the limits and possibilities of the data mining technology.
Contents	• Analysis of large data sets from various industrial application areas • Data classification • Error detection • Simulation • Optimization • Identification of test samples • Sampling procedures • Statistical analysis • Planning of experiments • Usage (incl. programming) of data mining tools, e.g. SAS, S, R
Units	Lectures and exercises

Total workload (h)	150
Language	English
Module frequency	Summer semester

8. Module: Advanced IT-Security	
Study program	M.Sc. High-Integrity Systems
Code	
Applicability	Applicable in other computer science master curricula
Semester	1
Duration	1 Semester
Credits	5 CP
Preconditions for module participation	None; recommended prerequisites: good knowledge in introductory computer science, C-programming, theoretical basics of computer science, networks, operating systems
Requirements for module examination	None
Module examination	oral examination of at least 15 and maximum 45 minutes duration at the end of the semester
Status	Required module
Education goals/ capabilities	Upon completion of this course, the student is able to: • to identify, analyze, and perhaps solve network-related security problems in computer systems. • to understand security problems in the combination of the Internet with Intranets. • to comprehend the need to protect all architectural levels. • to get an understanding of how to coordinate hardware and software • to provide data security against internal and external attacks.
Contents	• Introduction • Distributed Systems and Networks • Security threats in computer networks and countermeasures • Firewalls • Cryptography • Distributed Systems and Applications
Units	Lectures and exercises
Total workload (h)	150
Language	English
Module frequency	Winter semester

9. Module: Advanced Testing Methods	
Study program	M.Sc. High-Integrity Systems
Code	
Applicability	Applicable in other computer science master curricula
Semester	2
Duration	1 Semester
Credits	5 CP
Preconditions for module participation	None; recommended prerequisites: extended knowledge in software engineering, very good programming skills in procedural and object-oriented programming languages
Requirements for module examination	None

Module examination	Written project report and oral presentation
Status	Required module
Education goals/ capabilities	Upon completion of this course, the student is able to: • assess different testing methodologies, • master various powerful testing procedures, • differentiate between the testing of procedural and object oriented software, • estimate the importance of safety criteria for test case design, • recognize the limits of testing capabilities.
Contents	• Planning for verification and validation • Design for testability • Testing strategies • Testing procedures • Testing of object-oriented systems • Testing patterns • Testing of and with safety criteria • Environment simulation • Testing tools
Units	Lectures and exercises
Total workload (h)	150
Language	English
Module frequency	Summer semester

10. Module: Standards and Certification	
Study program	M.Sc. High-Integrity Systems
Code	
Applicability	Applicable in other computer science and engineering curricula
Semester	2
Duration	1 Semester
Credits	5 CP
Preconditions for module participation	None; recommended prerequisites: extended knowledge in software engineering, very good programming skills in procedural and object-oriented programming languages
Requirements for module examination	None
Module examination	Written report and oral presentation
Status	Required Module
Education goals/ capabilities	Upon completion of this course, the student is able to: • assess the growing pressure to standardize the development of high-integrity systems, • understand the growing importance of software safety, • survey the body of standards, • distinguish between standards of different application fields, • understand the history of engineering for safety, • achieve the ability for certification work, • understand the roles of management and staff in certification work. Training for non-specialist competencies: Students learn • to search for, read, summarize and cite scientific literature on a large scale;

	• to read and interpret national and international standards; • to write a report as a scientific paper; • to give a scientific talk.
Contents	• Overview over certification in various fields of application • SCS Standards for Software e.g.: IEC 61508, EN 50128, DO-178B, MIL-STD-882D, IEC 601-1-4, IEC 60880, VDE0801, DIN V19250 • Commonalities and differences of various standards • Correlations between CMMI and ISO 9000
Units	Seminar
Total workload (h)	150; 65 for training in non-specialist competencies
Language	English
Module frequency	Summer semester

11. Module: System Theory and Modeling	
Study program	M.Sc. High-Integrity Systems
Code	
Applicability	Applicable in other computer science master curricula
Semester	2
Duration	1 Semester
Credits	5 CP
Preconditions for module participation	None; recommended prerequisites: good knowledge in discrete mathematics, analysis, numerical methods
Requirements for module examination	Successful participation in unit exercises
Module examination	Written examination of 90 minutes duration at the end of the semester
Status	Required Module
Education goals/ capabilities	Upon completion of this course, the student is able to: • assess the safety critical aspects of combined hard-/software systems. • understand the foundation of systems theory. • apply system modeling techniques to a real world application example.

Contents	• Introduction and Overview
	• Principles of systems theory
	• Neighboring disciplines
	• Systems theory
	  • System classes
	  • Systems structure
	  • Complexity
	• Modeling
	  • Model classes
	  • Mathematical tools
	  • Applied modeling
	  • Nonlinear systems
	  • Synergetics
	  • Evolution
	• Application examples

Units	Lectures and exercises
Total workload (h)	150
Language	English
Module frequency	Summer semester

12. Module: Transaction Management	
Study program	M.Sc. High-Integrity Systems
Code	
Applicability	Applicable in other computer science master curricula
Semester	2
Duration	1 Semester
Credits	5 CP
Preconditions for module participation	None; recommended prerequisites: good knowledge in the use of database systems, programming with higher programming languages
Requirements for module examination	None
Module examination	Written examination of 90 minutes duration at the end of the semester
Status	Required Module
Education goals/ capabilities	Upon completion of this course, the student is able to: • understand, why transaction Management is a perfect example for a technology originating from system software that makes systems more robust. • comprehend, that transaction management takes care of potential problems resulting from concurrent access to data and errors resulting from system failures. • use transaction management as a generic concept that handles failures independent from each individual application and transparently for the applications as well the users. • understand how the deployment of transaction systems can increase the robustness of a system without adding additional complexity to the application development.
Contents	• Concept of transactions • Theory of serialization • Synchronization procedures • Recovery • Distributed transactions • Extended transaction models
Units	Lectures and exercises
Total workload (h)	150
Language	English
Module frequency	Summer semester

13. Module: Multivariate Data Analysis	
Study program	M.Sc. High-Integrity Systems
Code	
Applicability	Applicable in other computer science and engineering master curricula
Semester	3
Duration	1 Semester
Credits	5 CP
Preconditions for module participation	None; recommended prerequisites: modules „Introductory Data Analysis“ and „Data Mining Methods“
Requirements for module examination	Successful participation in unit exercises

Module examination	Written examination of 90 minutes duration at the end of the semester
Status	Required Module
Education goals/ capabilities	Upon completion of this course, the student is able to: • learn advanced data analysis principles and methods. • apply multivariate data analysis methods to extensive data sets.

Contents	• Multivariate data analysis theory and application
	• PCA und partial least-squares
	• Multivariate calibration
	  • Classification
	  • Modeling
	  • Estimation
	• PLS
	• Batch-Modeling
	• Analysis of 3D-data tables

Units	Lectures and exercises
Total workload (h)	150
Language	English
Module frequency	Winter semester

14. Module: Pattern Oriented Software Architecture	
Study program	M.Sc. High-Integrity Systems
Code	
Applicability	Applicable in other computer science master curricula
Semester	2
Duration	1 Semester
Credits	5 CP
Preconditions for module participation	None; recommended prerequisites: good knowledge in principles and procedures of software engineering, programming skills object-oriented programming languages
Requirements for module examination	None
Module examination	Oral examination of at least 15 and maximum 45 minutes duration at the end of the semester
Status	Required module
Education goals/ capabilities	• Upon completion of this course, the student is able to: • understand the motives of the pattern community. • distinguish between different types of patterns. • apply patterns in the design of SCS. • assess new developments of pattern catalogs and languages.
Contents	• Software architecture • Origins of the pattern movement • Pattern-oriented software architecture: Architectural patterns, Design patterns, Idioms • Application-specific pattern systems • Patterns for software testing • Pattern languages • Alternatives, e.g. Frameworks
Units	Lectures and exercises
Total workload (h)	150

Language	English
Module frequency	Winter semester

15. Module: Formal Specification and Verification	
Study program	M.Sc. High-Integrity Systems
Code	
Applicability	Applicable in other computer science master curricula
Semester	3
Duration	1 Semester
Credits	5 CP
Preconditions for module participation	None; recommended prerequisites: Module “Advanced Formal Modeling”
Requirements for module examination	Successful participation in unit exercises
Module examination	Written examination of 90 minutes duration at the end of the semester
Status	Required module
Education goals/ capabilities	Upon completion of this course, the student is able to: • understand the principles of formal approaches to software engineering. • compare processes based on formal methods to other process models. • define a formal specification. • carry out a formal verification. • understand the relationship between a formal verification proof and a non-formal verification. • assess the practical limitations of formal methods. • contemplate the usage of formal methods in a real -world problem setting.
Contents	• Procedures for formal specifications • Formal modeling in software process models • Safety analysis in formal specifications • Systems development using formal languages • Validation and verification of formal specifications • Applying formal proof techniques • Application of Computer-Aided Proof Systems • Tool support for formal techniques • Formal model of software components • Formal methods and metrics • Practical limitations of formal methods • Example application in the field of „High Integrity Systems“
Units	Lectures and exercises
Total workload (h)	150
Language	English
Module frequency	Winter semester

16. Module: Simulation Methods	
Study program	M.Sc. High-Integrity Systems
Code	
Applicability	Applicable in other computer science master curricula
Semester	3
Duration	1 Semester

Credits	5 CP
Preconditions for module participation	None; recommended prerequisites: good knowledge in numerical methods, very good programming skills in procedural and object-oriented programming languages, module “System Theory and Modeling”
Requirements for module examination	Successful participation in unit exercises
Module examination	Written examination of 90 minutes duration at the end of the semester
Status	Required module
Education goals/ capabilities	Upon completion of this course, the student is able to: • assess the growing importance of simulation for high-integrity systems, • understand the interaction between simulation and experimental verification, • get an overview over simulation methods, • get experience in using simulation tools, • recognize the limitations of simulation work.

Contents	• Visualisation of simulations
	• Numerical methods
	• Discrete procedures
	• Types of simulation
	• Software tools
	  • Mathematica
	  • CAEDS
	• Application examples

Units	Lectures and exercises
Total workload (h)	150
Language	English
Module frequency	Winter semester

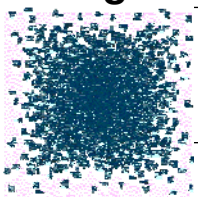
17. Module: High-Integrity Systems Project	
Study program	M.Sc. High-Integrity Systems
Code	
Applicability	Applicable in other computer science master curricula
Semester	3
Duration	1 Semester
Credits	10 CP
Preconditions for module participation	None; recommended prerequisites: excellent knowledge of software engineering, very good programming skills in procedural and object-oriented programming languages
Requirements for module examination	None
Module examination	Written project report and oral presentation
Status	Required module
Education goals/ capabilities	Upon completion of this course, the student is able to: • develop a high-integrity software application with real-world requirements, • work in a group environment with distributed responsibilities, • gain experience in all fields of software engineering and certification of high-integrity software, • and assess the problems of applying scientific knowledge in a real

	world R&D – situation. Training for non-specialist competencies: Students learn • to explore and to adapt to a commercial R&D environment; • to organize a research team; • to use modern tools for project organization; • to make industrial presentations; • to write a report as a scientific paper.
Contents	The project should be based on a collaboration with an industrial partner. Preferably the practical work should be done in residence. The topic of the project covers several core areas of computer science.
Units	Group project
Total workload (h)	300; 100 in training for non-specialist competencies
Language	English
Module frequency	Winter semester

18. Module: Master Thesis	
Study program	M.Sc. High-Integrity Systems
Code	
Applicability	
Semester	4
Duration	1 Semester
Credits	30 CP
Preconditions for module participation	None; recommended prerequisites: all modules of the first 3 semesters
Requirements for module examination	Successful termination of all modules of the first 3 semesters and of master thesis
Module examination	Master Thesis and colloquium of at least 30 and maximum 60 minutes duration
Status	Required module
Education goals/ capabilities	Upon completion of the master thesis, the student is able to: • develop completely an extensive high-integrity software application with real-world requirements, • work in a larger group environment with distributed responsibilities, • gain experience in all fields of software engineering and certification of high-integrity software, • and assess the problems of applying scientific knowledge in a real world R&D – situation. Training for non-specialist competencies: Students learn • to learn scientific project management;. • to use modern tools for project organization; • to write the thesis as a comprehensive scientific report; • to defend a thesis in a scientific colloquium.
Contents	The project may be based on a collaboration with an industrial partner. Preferably the practical work should be done in residence. The topic of the project covers several core areas of computer science.
Units	Thesis project

Total workload (h)	900; 60 in training for non-specialist competencies
Language	English
Module frequency	Summer semester

Anlage 4: Diploma Supplement



Fachhochschule Frankfurt am Main - University of Applied Sciences

Diploma Supplement

This Diploma Supplement follows the model developed by the European Commission, Council of Europe and UNESCO/CEPES. The purpose of the supplement is to provide sufficient independent data to improve the international „transparency" and fair academic and professional recognition of qualifications (diploma, degrees, certificates, etc.) . It is designed to provide a description of the nature, level, context, content and status of the studies that were pursued and successfully completed by the individual named on the original qualification to which this supplement is appended. It should be free of any value judgements, equivalence statements or suggestions about recognition. Information in all sections should be provided. Where information is not provided, an explanation should give the reason why.

1. HOLDER OF THE QUALIFICATION

1.1 Family Name / 1.2 First Name

individuell

1.3 Date, Place, Country of Birth

Individuell

1.4 Student ID Number or Code

Individuell

2. QUALIFICATION

2.1 Name of Qualification / Titel Conferred (full, abbreviated; in original language)

Master of Science, M.Sc.

2.2 Main Field(s) of Study

Computer Science specifically High-Integrity Systems

2.3 Institution Awarding the Qualification (in original language)

Fachhochschule Frankfurt am Main - University of Applied Sciences

Department of Computer Science and Engineering

Status (Type / Control)

University of Applied Sciences / State Institution

2.4 Institution Administering Studies (in original language)

(same)

Status (Type / Control)

(same)

2.5 Language(s) of Instruction/Examination

English

3. LEVEL OF THE QUALIFICATION

3.1 Level

Graduate degree

3.2 Official Length of Programm

2 years, 120 CP

3.3 Access Requirements

For the Master's programe students can only be admitted who:

- hold a Bachelor degree graded "good" or better in the same or related subject area. International applicants will be checked according to national regulations of credential evaluation.
- have proved sufficient English language skills

4. CONTENTS AND RESULTS GAINED

4.1 Mode of Study

Full time

4.2 Programme Requirements/ Qualification Profile of the Graduate

The aims and objectives are as follows:

Upon completion of the curriculum the students should be able to:

1. distinguish between reliability, safety and security
2. perform a hazard analysis of a computer-based system
3. write requirements for a safety-critical system and trace safety constraints to design
4. work with human factors experts in the design of safe human-computer interaction
5. apply the principles of safe design to both systems and software
6. criticize and evaluate a system design for safety and security
7. design a process for building a safety-critical system
8. gain experience in the application of data analysis methods and procedures
9. assess the information content and quality of data with respect to requirements
10. provide verified data for high-integrity applications
11. achieve the ability for certification work
12. assess the problems of applying scientific knowledge in a real-world R&D situation
13. develop a high-integrity software application with real-world requirements
14. make use of abstract methods, structures and patterns and be familiarized with the principles of Computer Science and underlying subjects
15. show core competences in the main areas of computer science, system analysis, programming and use of complex applications
16. apply current professional methods of software development in theory and practice
17. adapt new technologies and application areas
18. work in teams to show negotiation and presentation skills and to develop professional perspectives as well as effective applications of Computer Science in various areas.

4.3 Programme details

See “Transcript of records” for list of courses and grades, and “Prüfungszeugnis” (Final Examination Certificate) for subjects offered in final examinations (written and oral), and topic of thesis, including evaluations.

4.4 Grading Scheme

General grading scheme cf. Sec. 8.6 – In addition, the ECTS grading scheme is used which operates with the levels A (best 10%), B (next 25%), C (next 30%), D (next 25%), E (next 10%).

4.5 Overall Classification (in original language)

Individuell: sehr gut; gut; befriedigend; ausreichend

Based on the accumulation of grades received during the study programe and the final thesis.

cf. Masterzeugnis (Final Examination Certificate)

5. FUNCTION OF THE QUALIFICATION

5.1 Access to Further Study

Qualifies for admission to doctoral –PhD- studies.

5.2 Professional status

The M.Sc.-degree entitles its holder to exercise professional work in the field of computer science in corporate and public institutions.

6. ADDITIONAL INFORMATION

6.1 Additional Information

6.2 Further information sources

On the institution: www.fh-frankfurt.de

On the program: www.fb2.fh-frankfurt.de

For national information sources cf. Sect. 8.8

7. CERTIFICATION

This Diploma Supplement refers to the following documents:
Urkunde über die Verleihung des Bachelor-Grades vom TAG.MONAT.JAHR
Prüfungszeugnis vom TAG.MONAT.JAHR
Transcript of records vom TAG.MONAT.JAHR

8. NATIONAL HIGHER EDUCATION SYSTEM

The information on the national higher education system on the following pages provides a context for the qualification and the type of higher education that awarded it.

Chairperson, Examination Committee (Official Stamp/ seal)

8. INFORMATION ON THE GERMAN HIGHER EDUCATION SYSTEM [i]

8.1 Types of Institutions and Institutional Status

Higher education (HE) studies in Germany are offered at three types of Higher Education Institutions (HEI). [ii]

- *Universitäten* (Universities) including various specialized institutions, offer the whole range of academic disciplines. In the German tradition, universities focus in particular on basic research so that advanced stages of study have mainly theoretical orientation and research-oriented components.

- *Fachhochschulen* (Universities of Applied Sciences) concentrate their study programmes in engineering and other technical disciplines, business-related studies, social work, and design areas. The common mission of applied research and development implies a distinct application-oriented focus and professional character of studies, which include integrated and supervised work assignments in industry, enterprises or other relevant institutions.

- *Kunst- und Musikhochschulen* (Universities of Art/Music) offer studies for artistic careers in fine arts, performing arts and music; in such fields as directing, production, writing in theatre, film, and other media; and in a variety of design areas, architecture, media and communication.

Higher Education Institutions are either state or state-recognized institutions. In their operations, including the organization of studies and the designation and award of degrees, they are both subject to higher education legislation.

8.2 Types of Programmes and Degrees Awarded

Studies in all three types of institutions have traditionally been offered in integrated "long" (one-tier) programmes leading to *Diplom*- or *Magister Artium* degrees or completed by a *Staatsprüfung* (State Examination).

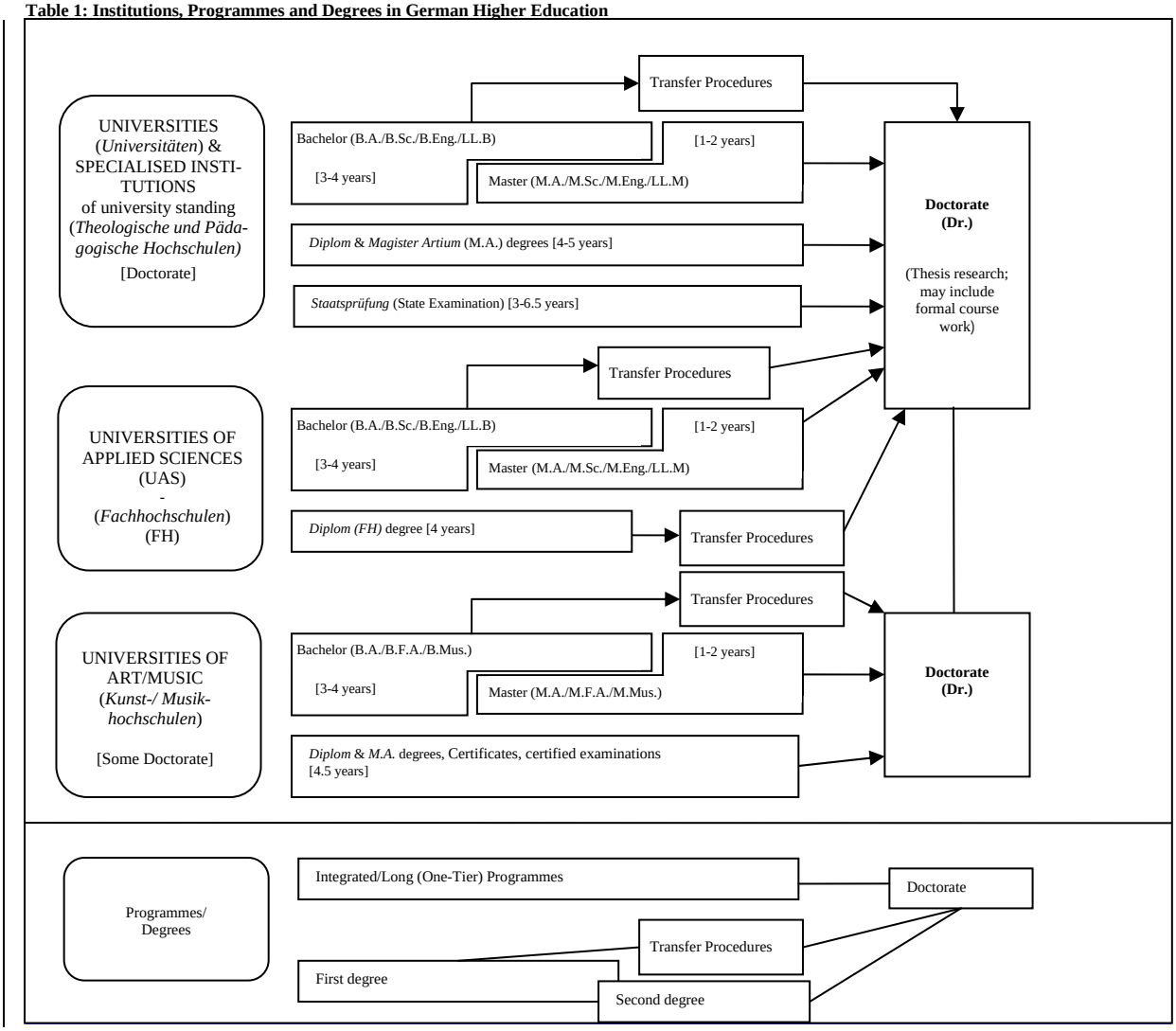
Within the framework of the Bologna-Process one-tier study programmes are successively being replaced by a two-tier study system. Since 1998, a scheme of first- and second-level degree programmes (Bachelor and Master) was introduced to be offered parallel to or instead of integrated "long" programmes. These programmes are designed to provide enlarged variety and flexibility to students in planning and pursuing educational objectives, they also enhance international compatibility of studies.

For details cf. Sec. 8.4.1, 8.4.2, and 8.4.3 respectively. Table 1 provides a synoptic summary.

8.3 Approval/Accreditation of Programmes and Degrees

To ensure quality and comparability of qualifications, the organization of studies and general degree requirements have to conform to principles and regulations established by the Standing Conference of the Ministers of Education and Cultural Affairs of the *Länder* in the Federal Republic of Germany (KMK). [iii] In 1999, a system of accreditation for programmes of study has become operational under the control of an Accreditation Council at national level. All new programmes have to be accredited under this scheme; after a successful accreditation they receive the quality-label of the Accreditation Council. [iv]

Table 1: Institutions, Programmes and Degrees in German Higher Education



8.4 Organization and Structure of Studies

The following programmes apply to all three types of institutions. Bachelor's and Master's study courses may be studied consecutively, at various higher education institutions, at different types of higher education institutions and with phases of professional work between the first and the second qualification. The organization of the study programmes makes use of modular components and of the European Credit Transfer and Accumulation System (ECTS) with 30 credits corresponding to one semester.

8.4.1 Bachelor

Bachelor degree study programmes lay the academic foundations, provide methodological skills and lead to qualifications related to the professional field. The Bachelor degree is awarded after 3 to 4 years.
The Bachelor degree programme includes a thesis requirement. Study courses leading to the Bachelor degree must be accredited according to the Law establishing a Foundation for the Accreditation of Study Programmes in Germany. [v]
First degree programmes (Bachelor) lead to Bachelor of Arts (B.A.), Bachelor of Science (B.Sc.), Bachelor of Engineering (B.Eng.), Bachelor of Laws (LL.B.), Bachelor of Fine Arts (B.F.A.) or Bachelor of Music (B.Mus.).

8.4.2 Master

Master is the second degree after another 1 to 2 years. Master study programmes must be differentiated by the profile types "more practice-oriented" and "more research-oriented". Higher Education Institutions define the profile of each Master study programme.
The Master degree study programme includes a thesis requirement. Study programmes leading to the Master degree must be accredited according to the Law establishing a Foundation for the Accreditation of Study Programmes in Germany. [vi]
Second degree programmes (Master) lead to Master of Arts (M.A.), Master of Science (M.Sc.), Master of Engineering (M.Eng.), Master of Laws (L.L.M), Master of Fine Arts (M.F.A.) or Master of Music (M.Mus.). Master study programmes, which are designed for continuing education or which do not build on the preceding Bachelor study programmes in terms of their content, may carry other designations (e.g. MBA).

8.4.3 Integrated "Long" Programmes (One-Tier): *Diplom* degrees, *Magister Artium, Staatsprüfung*

An integrated study programme is either mono-disciplinary (*Diplom* degrees, most programmes completed by a *Staatsprüfung*) or comprises a combination of either two major or one major and two minor fields (*Magister Artium*). The first stage (1.5 to 2 years) focuses on broad orientations and foundations of the field(s) of study. An Intermediate Examination (*Diplom-Vorprüfung* for *Diplom* degrees; *Zwischenprüfung* or credit requirements for the *Magister Artium*) is prerequisite to enter the second stage of advanced studies and specializations. Degree requirements include submission of a thesis (up to 6 months duration) and comprehensive final written and oral examinations. Similar regulations apply to studies leading to a *Staatsprüfung*. The level of qualification is equivalent to the Master level.

- Integrated studies at *Universitäten (U)* last 4 to 5 years (*Diplom* degree, *Magister Artium*) or 3 to 6.5 years (*Staatsprüfung*). The *Diplom* degree is awarded in engineering disciplines, the natural sciences as well as economics and business. In the humanities, the corresponding degree is usually the *Magister Artium* (M.A.). In the social sciences, the practice varies as a matter of institutional traditions. Studies preparing for the legal, medical, pharmaceutical and teaching professions are completed by a *Staatsprüfung*.
The three qualifications (*Diplom*, *Magister Artium* and *Staatsprüfung*) are academically equivalent. They qualify to apply for admission to doctoral studies. Further prerequisites for admission may be defined by the Higher Education Institution, cf. Sec. 8.5.

- Integrated studies at *Fachhochschulen (FH)*/Universities of Applied Sciences (UAS) last 4 years and lead to a *Diplom (FH)* degree. While the *FH*/UAS are non-doctorate granting institutions, qualified graduates may apply for admission to doctoral studies at doctorate-granting institutions, cf. Sec. 8.5.

- Studies at *Kunst- and Musikhochschulen* (Universities of Art/Music etc.) are more diverse in their organization, depending on the field and individual objectives. In addition to *Diplom/Magister* degrees, the integrated study programme awards include Certificates and certified examinations for specialized areas and professional purposes.

8.5 Doctorate

Universities as well as specialized institutions of university standing and some Universities of Art/Music are doctorate-granting institutions. Formal prerequisite for admission to doctoral work is a qualified Master (UAS and U), a *Magister* degree, a *Diplom*, a *Staatsprüfung*, or a foreign equivalent. Particularly qualified holders of a Bachelor or a *Diplom (FH)* degree may also be admitted to doctoral studies without acquisition of a further degree by means of a procedure to determine their aptitude. The universities respectively the doctorate-granting institutions regulate entry to a doctorate as well as the structure of the procedure to determine aptitude. Admission further requires the acceptance of the Dissertation research project by a professor as a supervisor.

8.6 Grading Scheme

The grading scheme in Germany usually comprises five levels (with numerical equivalents; intermediate grades may be given): "*Sehr Gut*" (1) = Very Good; "*Gut*" (2) = Good; "*Befriedigend*" (3) = Satisfactory; "*Ausreichend*" (4) = Sufficient; "*Nicht ausreichend*" (5) = Non-Sufficient/Fail. The minimum passing grade is "*Ausreichend*" (4). Verbal designations of grades may vary in some cases and for doctoral degrees.
In addition institutions may already use the ECTS grading scheme, which operates with the levels A (best 10 %), B (next 25 %), C (next 30 %), D (next 25 %), and E (next 10 %).

8.7 Access to Higher Education

The General Higher Education Entrance Qualification (*Allgemeine Hochschulreife, Abitur*) after 12 to 13 years of schooling allows for admission to all higher educational studies. Specialized variants (*Fachgebundende Hochschulreife*) allow for admission to particular disciplines. Access to *Fachhochschulen* (UAS) is also possible with a *Fachhochschulreife*, which can usually be acquired after 12 years of schooling. Admission to Universities of Art/Music may be based on other or require additional evidence demonstrating individual aptitude.
Higher Education Institutions may in certain cases apply additional admission procedures.

8.8 National Sources of Information

- *Kultusministerkonferenz (KMK)* [Standing Conference of the Ministers of Education and Cultural Affairs of the *Länder* in the Federal Republic of Germany]; Lennéstrasse 6, D-53113 Bonn; Fax: +49[0]228/501-229; Phone: +49[0]228/501-0
- Central Office for Foreign Education (ZaB) as German NARIC; www.kmk.org; E-Mail: zab@kmk.org
- "Documentation and Educational Information Service" as German EURYDICE-Unit, providing the national dossier on the education system (www.kmk.org/doku/bildungswesen.htm; E-Mail: eurydice@kmk.org)
- *Hochschulrektorenkonferenz (HRK)* [German Rectors' Conference]; Ahrstrasse 39, D-53175 Bonn; Fax: +49[0]228/887-110; Phone: +49[0]228/887-0; www.hrk.de; E-Mail: sekr@hrk.de
- "Higher Education Compass" of the German Rectors' Conference features comprehensive information on institutions, programmes of study, etc. (www.higher-education-compass.de)

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[i] The information covers only aspects directly relevant to purposes of the Diploma Supplement. All information as of 1 July 2005.

[ii] *Berufsakademien* are not considered as Higher Education Institutions, they only exist in some of the *Länder*. They offer educational programmes in close cooperation with private companies. Students receive a formal degree and carry out an apprenticeship at the company. Some *Berufsakademien* offer Bachelor courses which are recognized as an academic degree if they are accredited by a German accreditation agency.

[iii] Common structural guidelines of the *Länder* as set out in Article 9 Clause 2 of the Framework Act for Higher Education (HRG) for the accreditation of Bachelor's and Master's study courses (Resolution of the Standing Conference of the Ministers of Education and Cultural Affairs of the *Länder* in the Federal Republic of Germany of 10.10. 2003, as amended on 21.4.2005).

[iv] "Law establishing a Foundation 'Foundation for the Accreditation of Study Programmes in Germany'", entered into force as from 26.2.2005, GV. NRW. 2005, nr. 5, p. 45 in connection with the Declaration of the *Länder* to the Foundation "Foundation: Foundation for the Accreditation of Study Programmes in Germany" (Resolution of the Standing Conference of the Ministers of Education and Cultural Affairs of the *Länder* in the Federal Republic of Germany of 16.12.2004.

[v] See note No. 4.

[vi] See note No. 4.