



Magdeburg, July 10th, 2018

Written Exam "Advanced Database Models"

Name:	Firstname:
Immatriculation Number:	
Course of Studies: DKE, DigiEng, WIF, CV, INF, IngIf (underline your course)	
Number of additionally submitted sheets :	
Student signature:	Examinant signature:

Filled out by the examiners:

Part 1: Foundations	Part 2: ER and UML	Part 3: NF2 and eNF2	Part 4: OO and OR	Part 5: XML	Part 6: Single Choice, True False	Overall
(of 10)	(of 15)	(of 15)	(of 30)	(of 10)	(of 20)	(of 100)

Hints for the exam:

- Please check the completeness of the exam sheets **(10 sheets, 20 pages)**.
- Fill out the first page with your personal data. Write your name in the according fields in the header of all of the following sheets.
- For the answers, use the space left between the questions. Use additional free pages at the end for further answers (do not forget to reference the number of the question). If additional paper is required, please contact the examiners. Do not use your paper.
- Do not use red or green pens. Do not use a pencil. Black and blue ballpoint or fountain pens preferred.
- Put the required things on the table, i.e. pens, student ID card, food/beverages.
- Turn off your mobile phone!
- Do not use any impermissible help (containing content of the lecture, allowing outside communication), especially books, slides, notes, printouts, mobile phones, etc.
- Using impermissible help will be considered an attempt of fraud and will cause the rejection from the exam. The exam will be graded as 5.0 ("not passed").
- Write clearly. Unreadable parts will not be considered.
- Answer only the posed questions. Additional text not referring to the questions will not be considered for extra points.

Good luck!

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Part 1: Basic Terms and Foundations (10 points)

1. Given the following example application:

The data of employees and their projects is managed in object tables. One attribute of employees is the department they work in. For the employee type there is a subtype defined to store information about apprentices.

- a. Explain the term *Database Model* and relate two of the underlined terms to it!
(3 points)

- b. Explain the term *Database Schema* and relate two of the underlined terms to it!
(3 points)

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2. The following following concepts are either possible in the *Relational Model* as suggested by Codd or in it's implementation as the *SQL Database Model*. Mark exactly one correct assignment for each concept (2 points, 0.5 per correct answer)

	Relational Model	SQL
NULL-values allowed	<input type="checkbox"/>	<input type="checkbox"/>
Duplicate rows possible	<input type="checkbox"/>	<input type="checkbox"/>
Row order insignificant	<input type="checkbox"/>	<input type="checkbox"/>
Column order may be significant	<input type="checkbox"/>	<input type="checkbox"/>

3. Explain the term *Object-relational Impedance Mismatch!* (2 points)

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Part 2: Conceptual Models – Extended ER and UML (15 points)

4. Name and explain two differences between *Conceptual* and *Logical Database Models*!
(4 points)

5. Name one aspect that can be expressed in UML Class Diagrams, but cannot be expressed in (the introduced extended notation by Elmasri/Navatheof) ER Diagrams!
(1 point)

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6. The following example scenario is given:

Books have the attributes title and ISBN, where the latter is used as a key attribute. E-Books are a subtype of books with an additional attribute for the file format. Printed books are a further subtype of books, with an additional attribute for the number of pages. E-Books cannot be printed books and vice versa. In the modelled application scenario, there are no books which are neither e-books nor printed books.

- a. Using the extended ER notation introduced by Elmasri/Navathe draw an ER diagram for the scenario! (4 points)

Name: _____

- b.** In the lecture three ways to map an object-oriented design to a purely relational database were discussed. Using the developed ER diagram of task 6a, illustrate two approaches chosen by you. For each of them, name at least one disadvantage! (6 points)

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Part 3: Nested Relations and Type Constructors in NF^2 and eNF^2 (15 points)

7. What does the abbreviation NF^2 stand for? How are NF^2 relations different from plain relations according to the *Relational Database Model*? (2 points)

8. What is the *Partitioned Normal Form* (PNF)? Is the following nested table in PNF? Explain your answer! (4 points)

A	B	
	C	D
1	3	4
	4	5
2	6	7
	7	8
3	9	10
	10	11

Name: _____

9. Contrary to the NF^2 data model, in the eNF^2 data model type constructors can be combined freely. Give one example that is not possible in NF^2 ! (2 points)
10. Name and explain two differences between the `array` and `set` *Type Constructors*! (2 points)
11. Of the type constructors `tuple`, `set`, `bag`, `array`, and `list` only three are supported as explicit type constructors in SQL:2003? Which three are supported? (3 points, for incorrect answers points are subtracted, minimum points are 0)

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Part 4: Object-oriented and Object-relational Database Models (30 points)

12. For the object-oriented concept of Specialization, explain the two aspects referred to as *Intensional* and *Extensional Specialization*! (4 points)

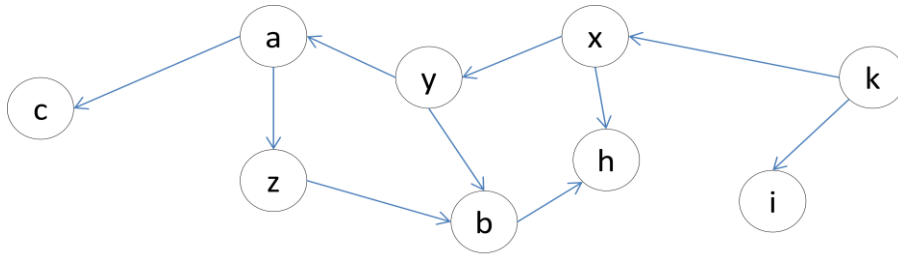
13. While in relational databases *Primary Keys* are used for identification, object-oriented and object-relational systems use *Object Identities* (OIDs). Name and explain two differences between the two concepts! (4 points)

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- 14.** For Object-oriented Database systems, explain the difference between *Pre-* and *Post-Processor* approaches for *Schema Implementation!* (4 points)

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15. Given the following example object graph:



Of the objects *a* to *z*, which one would be a suitable *Named Object* (root object) to store the entire graph? Why? Related to this, what does the term *Persistence by Reachability* mean? (4 points)

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16. Name three *Differences of Object Tables* compared to *Relational Tables* in an Object-relational database! (3 points)

17. What does the *Scope of a reference* attribute in an Object-relational database define? Name one example of a possible scope constraint? (2 points)

Name: _____

18. Using an SQL:2003 compliant Database Management Systems the following database is created:

```
CREATE TYPE aType AS (x INTEGER, y INTEGER) NOT FINAL;  
CREATE TYPE bType UNDER aType AS (z INTEGER) FINAL;  
CREATE TABLE aTable OF aType;  
CREATE TABLE bTable OF bType UNDER aTable;  
INSERT INTO aTable VALUES (1, 2);  
INSERT INTO aTable VALUES (3, 4);  
INSERT INTO bTable VALUES (5, 6, 7);
```

What would be the results of the following queries (how many columns, how many rows)? Explain!

a. `SELECT * FROM aTable;` (3 points)

b. `SELECT * FROM ONLY (aTable);` (3 points)

c. `SELECT * FROM bTable;` (3 points)

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Part 5: Semi-structured Data and XML (10 points)**19.** Given the following two simple XML fragments:

Fragment A

Fragment B

- a.** Which one is *well-formed*? Explain!
(3 points)

```
<a>
  <b>
    123
  </b>
  <c>
    456
  </c>
</a>
```

```
<a>
  <b>
    123
  <c>
    456
  </b>
  </c>
</a>
```

- b.** Is the well-formed fragment *valid* according to the following element declarations in a DTD? Explain! (3 points)

```
<!ELEMENT a (b, c?, d) >
<!ELEMENT b (#PCDATA) >
<!ELEMENT c (#PCDATA) >
<!ELEMENT d (#PCDATA) >
```

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20. Given the two following example XML document

```
<library>
  <book>
    <title>Databases for Dummies</title>
    <author>Kubrick</author>
    <author>Spielberg</author>
  </book>
  <journal vol="207">
    <title>Databases for Smarties</title>
  </journal>
  <journal vol="301">
    <title>International Journal on Databases</title>
  </journal>
</library>
```

provide XPath queries that return

a) all authors of books (2 points)

b) the title of journal volume 207 (2 points)

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Part 6: Single-Choice /True-False-Questions (20 points)**21. Single Choice Questions**

For the following statements mark **exactly one** headword to continue the statement correctly. A correct mark scores one point for each statement. For an incorrect mark 1 point is subtracted. No mark is 0 points. Accordingly, only mark answers where you are very certain about the correctness. The overall score cannot be less than 0.

- a.** An alternative to the ER-Model for conceptual database design are
- UML Sequence Diagrams
 - UML Use Case Diagrams
 - UML Class Diagrams
- b.** If an instance of a type can be an instance of more than one subtype (e.g. in an ER diagram using the Elmasri/Navathe notation) we refer to this as
- total specialization
 - overlapping specialization
 - partial specialization
- c.** An insert operation on a set (type constructor) leaves the set unchanged if
- the item to be inserted is already contained in the set
 - the set has reached its specified maximum array length
 - the set is a multiset
- d.** In SQL:1999 an explicit tuple type constructor was introduced as
- STRUCT
 - RECORD
 - ROW
- e.** The UNNEST operation of the SQL standard is implemented in Oracle as the
- NATURAL JOIN operation
 - COLLECT () aggregate function
 - TABLE () function

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- f. An implementation- or application-independent schema definition for object-oriented databases can be provided using the
- Object Definition Language (ODL)
 - Object Modeling Guide (OMG)
 - C++ Programming Language
- g. In ORDBMS the stored value of a Reference Type attribute is
- a physical address in memory
 - a primary key value
 - an Object Identifier (OID)
- h. Contrary to XML Schema, Document Type Definitions (DTDs) support as basic data types only
- text data (#PCDATA, #CDATA, etc.)
 - binary data (BLOB, image, video, etc.)
 - bag, tuple, and array
- i. In Object-oriented Database Systems, the requirement that persistent and transient objects of a persistent-capable class can be handled uniformly, is referred to as
- late binding
 - persistence independence
 - persistence by reachability
- j. An object type is created in Oracle using the syntax
- CREATE TYPE** typename **AS OBJECT** (...);
 - CREATE OBJECT** typename **WITH TYPE** (...);
 - CREATE OBJECT TYPE** typename (...);

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22. True or false? (10 points)

In the following table please mark whether the statement is true or false. A correct mark scores one point for each statement. For an incorrect mark 1 point is subtracted. No mark is 0 points. Accordingly, only mark answers where you are very certain about the correctness. The overall score cannot be less than 0.

	True	False
1. An XML document that is not <i>well-formed</i> cannot be <i>valid</i> .		
2. An XML document that is not <i>valid</i> cannot be <i>well-formed</i> .		
3. The addition of <i>NULL-values</i> in the SQL data model implied the need for a three-valued logic.		
4. <i>Object-relational concepts</i> were added to SQL with SQL-92.		
5. Performing the <i>Unnest</i> and <i>Nest</i> operations of the NF ² model sequentially may result in information loss.		
6. <i>Multiple Inheritance</i> refers to the fact, that one supertype may have several subtypes.		
7. In Object-relational databases <i>Methods</i> must be implemented using SQL.		
8. The <i>Flat Extension</i> of a type consists only of direct instances of the type, but not of instances of any subtypes.		
9. Oracle does not support <i>View Hierarchies</i> .		
10. <i>Element Nodes</i> in an XML structure (document and according DTD) may be defined as optional.		

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Name: _____