Otto-von-Guericke-Universität Magdeburg
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Magdeburg, February 17th, 2016

Written Exam "Data Management for Engineering Applications"

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 examinants:

Part 1: Foundations	**Part 2:** Product Data	**Part 3:** Product Lifecycle	**Part 4:** Single and True-False	**Overall**
(of 35)	(of 35)	(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 any 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 examinants. 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!

Name:_____

Part 1: Basic Terms and Foundations (35 Points)

1. Basic Terms (10 Points)

a. Give an example that illustrates the need for *Hierarchical Data Structures* in engineering applications! **(2 Points)**

b. Explain the term *Persistence*? Name 2 ways how persistence is typically achieved for engineering applications! **(3 Points)**

Name:_____

c. Explain the terms *Versions* and *Variants* in an engineering context! **(2 Points)**

d. Given the following excerpt from a STEP file, explain the terms *Data and Metadata* (schema)! Name the data model(s) that can be used for the schema definition (not contained in the example) of STEP files? **(3 Points)**

```
…
#5714=PACKAGE_TERMINAL('5','part generic feature',#95,.T.);
#5715=USAGE_CONCEPT_USAGE_RELATIONSHIP('',#17731,#5716,'',$
                                      ,#5714,#559,*);
#5716=AXIS2_PLACEMENT_2D('',#5718,#5717);
…
```

Name:_____

2. Data Models (19 Points)

a. Name and explain one advantage for each of *Text-based and Binary File Formats*! **(2 Points)**

b. In the *Relational Data Model*, how are the terms *Row, Columns, Primary Key* and *Table* related? **(2 Points)**

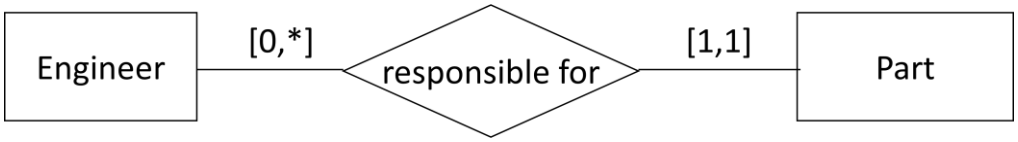
Name:_____

c. Given the design process of a database, explain the difference between *Conceptual and Logical Data Models*, and name data models typically used in the respective phases! **(4 Points)**

d. In SQL and the Relational Database Model, what are *Foreign Keys* used for? **(1 Point)**

Name:_____

e. **G**iven the following example of an *Entity Relationship Diagram*



which 2 of the following 4 real-world facts are **not** supported?

I There can be parts without a responsible Engineer.
II For every part there is exactly one and only one responsible Engineer.
III Not every engineer must be responsible for a part.
IV There is one engineer responsible for all parts.

Explain! **(4 Points)**

Name:_____

f. Given the following example of C++ class definitions, explain the object-oriented concepts of *Inheritance* and *Polymorphism*! **(4 Points)**

```
class ElectricalComponent
{
   private:
      string name;
      int    numberOfTerminals;
};

class Capacitor : public ElectricalComponent
{
   private:
       float  capacitance;
};
```

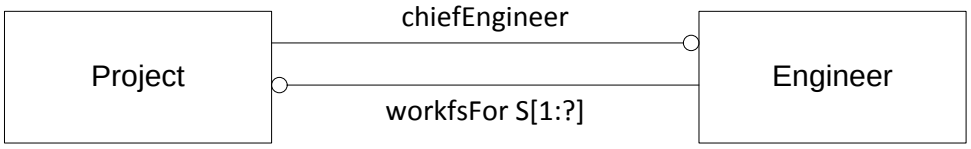
g. What does the term "*Valid* Document Structure" refer to in the context of eXtensible Markup Language (*XML*) files? **(2 Points)**

Name:_____

3. The STEP Standard (6 Points)

a. What are the purposes of the EXPRESS and EXPRESS-G languages defined as part of the STEP standard? What is the difference between them? **(2 Points)**

b. Given the following EXPRESS-G example diagram



which 2 of the following 4 real-world facts are **not** supported?

I An engineer may or may not work for any project.
II An engineer may work for many projects.
III For every project there is exactly one chief engineer.
IV There is a maximum number of engineers that may work for a project.

Explain! **(4 Points)**

Name:_____

Part 2: Product Data (35 Points)

4. Geometric Modeling (13 Points)

a. Explain the term *Geometric Modeling* and its importance for Engineering! **(4Points)**

b. Explain the difference between *Geometry and Topology* given geometrical and topological concepts from B-Rep! **(3 Points)**

Name:_____

c. What are the geometric primitives used for *Wireframe Models*? Name one disadvantage resulting from this approach? **(2 Points)**

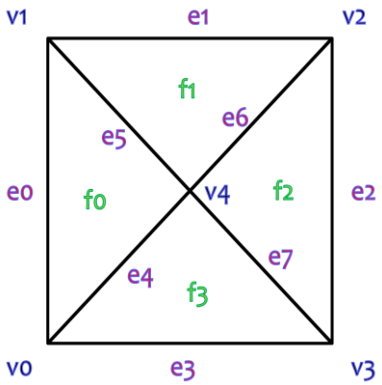
d. What are the operations of the *Construction Method* of *Constructive Solid Geometry* (CSG) that were integrated in the Boundary Representation Model? (**4 Points)**

Name:_____

5. Boundary Representation (BREP) and CAD Data (16 Points)

a. Explain how geometries can be described in BREP using the *Basic Topological Concepts* of shells, faces, loops, edges, and vertexes? **(5 Points)**

b. Given the following geometry:



To store edge e7 defined by vertexes v3 and v4, references to which edges e and faces f would additionally be stored with the *Winged Edge* data structure? **(3 Points)**

Name:_____

c. Explain the Sweeping Methods *Extrusion* and *Rotation* (Revolve)! **(2 Points)**

d. Of the 4 ways to manage *CAD Data using Relational Databases* introduced in the lecture, name and explain 2! **(4 Points)**

e. Name two *Geometric Modeling Kernels* typically used in CAD systems? **(2 Points)**

Name:_____

6. Electronic Engineering Data (6 Points)

a. For the two steps of electronic design, *Schematic Design* and *Physical Layout*, for each of them shortly describe their purpose and what data needs to be represented? **(6 Points)**

Name:_____

Part 3: Product Lifecycle Management (10 Points)

7. Product Lifecycle

a. Explain the difference between the terms *Product Development Process* and the *Product Lifecycle*! **(3 Points)**

b. Explain the term *"Islands of Automation"* in an engineering context! **(2 Points)**

Name:_____

8. Functionality of PLM Systems (5 Points)

a. What data is managed within the *Configuration Management* component of a PLM system? **(3 Points)**

b. Within the *Document Management*, what does the term *Document Structure* refer to? **(2 Points)**

Name:_____

Part 4: Single Choice / True-False-Questions (20 Points)

9. Single Choice Questions (10 Points)

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. A commonly used colloquial description of the term Metadata is

- ○ "data about products"
- ○ "data about data"
- ○ "data about applications"

b. A Database is

- ○ a specific software system independent of a universe of discourse
- ○ a collection of real world facts within a given universe of discourse
- ○ a domain specific query language for engineering applications

c. The Unified Modeling Language (UML) is

- ○ a data model for conceptual design
- ○ a general purpose geometrical model
- ○ a schema developed for the exchange of engineering data

d. Queries expressed using SQL are based on the typical

- ○ CREATE-UPDATE-FROM-block
- ○ SELECT-FROM-WHERE-block
- ○ ENTITY-ATTRIBUTE-VALUE-block

e. ENUMERATION types in STEP EXPRESS are used to declare

- ○ numerical attributes (of type INTEGER or REAL)
- ○ optional attributes (that may or may not have a value)
- ○ categorical attributes (with a few pre-defined values)

Name:_____

f. STEP files as defined in ISO 10303-21 are

- ○ binary files
- ○ text files
- ○ XML files

g. Electronic Design Automation (EDA) are tools to

- ○ plot technical drawings designed in CAD
- ○ create a 3D prototype from a 2D sketch
- ○ support the development of electronic circuits

h. The EAGLE (Easily Applicable Graphical Layout Editor) file format is based on

- ○ UML
- ○ XML
- ○ DXF

i. Each line in the data segment of an ISO 10303-21 STEP file starts with

- ○ a line number for further references to the entity
- ○ the type number of the entity described in this line
- ○ the Application Protocol (AP) number of the entity type

j. Storing complex data, e.g. engineering data, in Relation Database Systems leads to poor performance because

- ○ data is often archived on tape or disc and needs to be read from there
- ○ data is stored in possibly many tables and needs to be joined
- ○ each access requires a full scan of the entire database

Name:_____

10. 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. Current Product Lifecycle Management (PLM) systems have their historical roots in so-called Engineering Databases.		
2. The Bill of Materials (BOM) is derived from sales quantities of produced goods of a company.		
3. Printed Circuit Boards (PCB) implement conductions of electronic circuits.		
4. The Topology describes transformations of geometrical elements and how they are connected to form complex shapes.		
5. The lack of standardization and acceptance of Relational Database Management Systems (RDBMS) is the main reason why they are not often used to store CAD data.		
6. The lack of standardization and acceptance of Object-oriented Database Management Systems (ODBMS) is the main reason why they are not often used to store CAD data.		
7. The Initial Graphics Exchange Specification (IGES) is a standardized format often used for the exchange of CAD data.		
8. The XML data model describes arbitrary networks of object nodes with according attributes and methods.		
9. SQL stands for “Structured Query Language”.		
10. The STEP standard ISO 10303 describes data structures for specific engineering domains in so-called application protocols.		

Name:_____

Name:_____