#### **Uppsala University**

### Department of Information Technology

Database Design I (1DL300) - 2018-10-25

**Instructions:** Read through the complete exam and note any unclear directives before you start solving the questions. For each question there can be one or more correct answers, but you can choose only one. If you choose a correct answer, you gain 1 point. A wrong answer does not generate negative points – but the teacher reserves the right to penalize answers that are outrageously wrong. The questions are divided into three sections with 8 questions each. To achieve a grade of 3, you must gain at least 14 points in the whole exam. To achieve a grade of 4, you must gain at least 17 points in the whole exam. To achieve a grade of 5, you must collect at least 20 points in the whole exam. Answers must be given exclusively on the answer sheet, at the end: answers given on the other sheets will be ignored.

**Allowed aids:** One A4 sheet with handwritten notes (both sides can be used) which must be handed in with your exam (remember to write your exam code in a corner). You are allowed to use dictionaries to and from English and a calculator.

## **General questions (useful for us)**

**Question G1 ♣** When have you attended the course?

- A Period 1, 2018
- B Period 2, 2017
- C Period 1, 2017
- D Period 2, 2016
- E Period 1, 2016
- F None of the previous answers

## **Question G2** ♣ How many lectures have you attended?

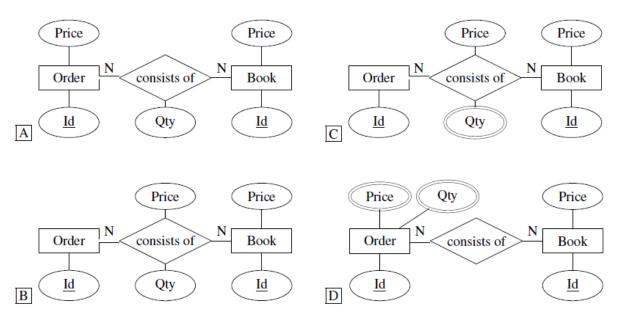
- A None or very few
- B Around 25%
- C Around 50%
- D Around 75%
- E Almost all

### **Question G3 ♣** What is your study program?

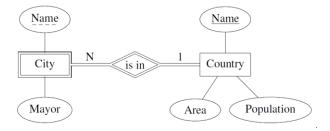
- A F
- B STS
- C CS
- D X
- E IT
- F None of the previous answers

## 1. Database design

**Question 1** In an online bookstore a customer can buy one or several books in a single order. It is, of course, possible to buy several copies of the same book. The prices of books might change so we need to store the prices of bought books in the order as well. Which of the following ER diagrams shows a correct way how to store orders? (Only the relevant portion of each diagram is shown, *Qty* stands for quantity. Ignore the value added tax.)

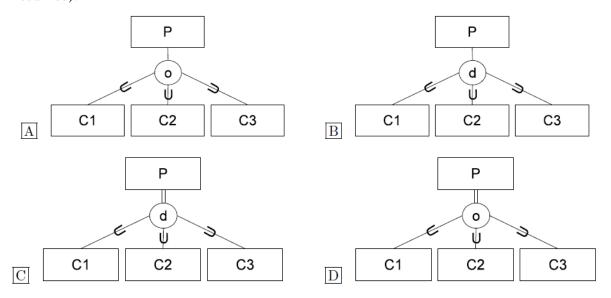


**Question 2** Which of the following statements about the depicted ER model is correct?

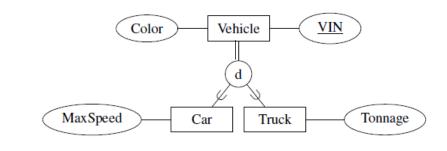


- A Same person cannot be mayor of two cities.
- B Each city is exactly in one country.
- C The population of a country is always larger than 0.
- D No two countries have exactly the same area and population.
- E The name of a city must be different from the name of a country.

**Question 3** Entity type P can be any type of C1, C2, C3 or none of these types. Namely, it can belong to more than one types at the same time; or, it can belong to none of them. Which of the following EER diagrams corresponds to these specifications? (only a portion of the diagram has been visualized)!

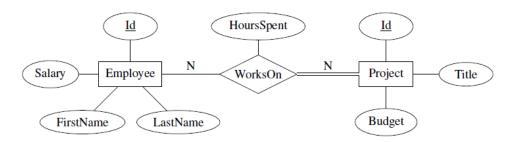


**Question 4** Consider we want to convert the following diagram to the relational model. Which of the following is the best answer?



- A Car(<u>VIN</u>, Color, MaxSpeed) Truck(<u>VIN</u>, Color, Tonnage)
- B Vehicle(<u>VIN</u>, Color) Car(MaxSpeed) Truck(Tonnage)
- C Vehicle(<u>VIN</u>, Color, MaxSpeed, Tonnage)
- D None of the other answers is correct!

**Question 5** Convert the following ER model to a relational model.



- A Employee(<u>Id</u>, FirstName, LastName, Salary, WorksOnId) with WorksOnId <sup>FK</sup>→WorksOn(Id) Project(<u>Id</u>, Title, Budget, WorksOnId) with WorksOnId <sup>FK</sup>→WorksOn(Id) WorksOn(<u>Id</u>, HoursSpent)
- B The ER model cannot be converted to a relational model because both Employee and Project have an attribute with the same name.
- C Employee(<u>Id</u>, FirstName, LastName, Salary)
   Project(<u>Id</u>, Title, Budget)
   WorksOn(<u>Eid</u>, Pid, HoursSpent) with Eid FK→ Employee(Id) and Pid FK→Project(Id)
- D Employee(<u>Id</u>, FirstName, LastName, Salary, HoursSpent)
  Project(<u>Id</u>, Title, Budget, HoursSpent)
  WorksOn(Eid, Pid,) with Eid <sup>FK</sup>→Employee(Id) and Pid <sup>FK</sup>→Project(Id)
- E None of the other answers is correct!

**Question 6** Consider a relation in 1NF R(<u>A, B, C, D, E, F</u>) with {A, B, C} as a composite primary key and the following dependencies:

- $\{A, B, C\} \rightarrow D, E, F$
- $\bullet \quad E {\longrightarrow} D$

Which of the following is true?

- A R is in 3NF (i.e. 3<sup>rd</sup> Normal Form) but not in 2NF (i.e. 2<sup>nd</sup> Normal Form)
- B R is in 2NF but not in 1NF
- C R is in 1NF but not in 2NF
- D R is in 2NF but not in 3NF
- E None of the other answers is correct!

Consider the following Staff Allocation Sheet. Where, each project has a unique Project Code and is associated with only one Customer. However a customer may be associated with many projects. Each customer has a unique Customer Number. Each staff member has a unique Staff No, Name and Grade and can work on many projects for a number of days.

# **Staff Allocation Sheet**

Project Code: 3411 Project Description: New Accounts

**Customer Number:** 3475 **Customer Name:** British Bakers

Staff No	Name	Grade	No of Days
34	Bloggs	S. Prog	12
12	Jones	Analyst	3
23	Brown	Manager	9
45	Williams	Teaboy	32

**Question 7** Which of the following functional dependencies are true?

- A Project Code → Project Description; {Project Code, Staff No}→No of Days
- B Project Code → Project Description; Staff No→{Name, Grade, No of Days}
- $\boxed{C}$  Customer Name  $\rightarrow$  Customer Number; Staff No $\rightarrow$ {Name, Grade}
- D None of the other answers

**Question 8** Considering the above Staff Allocation Sheet and the following relations:

PROJECT(<u>Project Code</u>, Project Description, Customer Number, Customer Name)

CUSTOMER (Customer Number, Customer Name)

PROJECTSTAFF(Project Code, Staff NO, Name, Grade, No of Days)

Which of the following is true?

- A None of the other answers is correct!
- B All relations are at least in 2NF (i.e. 2<sup>nd</sup> Normal Form)!
- C All relations are in 3NF (i.e. 3<sup>rd</sup> Normal Form)!
- D All relations are at least in 1NF (i.e. 1<sup>st</sup> Normal Form)!.

## 2. SQL

Consider the following database.

Т	71	T	2
C1	C2	C1	C2
A	1	A	4
A	2	A	2
В	2	В	2
C	1	D	5

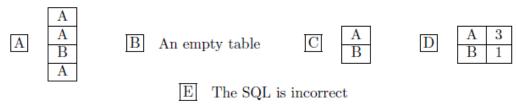
**Question 9** What is the result of the following SQL query?

SELECT count(\*) FROM T1, T2 WHERE T1.C1=T2.C1

- **A** 5
- $\mathbf{B} = 0$
- The SQL in incorrect
- **D** 2
- **E** None of the other answers is correct!
- **F** 16

Question 10 What is the result of the following SQL query?

SELECT distinct T1.C1 FROM T1, T2 WHERE T1.C1=T2.C1



**F** None of the other answers is correct!

Question 11	What is the	he result of	the following	ng SQL o	query?
SELECT T1 FROM T1, T WHERE T1	Γ2	1			
A A	В	An empt	v table	C	A

A	A A B	B An empty table	$\begin{array}{ c c }\hline C & \hline A \\ \hline B \end{array}$	D	A B	3
		E The SOL	is incorrect			

**F** None of the other answer is correct!

**Question 12** What is the result of the following SQL query?

SELECT T1.C1, SUM(T1.C2\*T2.C2) FROM T1, T2 WHERE T1.C1 = T2.C1 GROUP BY T1.C1

A SQL is invalid	C A 8 B 4
A 10	D A 22
B A 18 B 4	E A 12

F None of the other answers is correct!

**Question 13** What is the result of the following SQL query?

SELECT T1.C1, SUM(C2)\*4 FROM T1 WHERE T1.C1="A" GROUP BY T1.C1

A SQL is invalid	C A 8 B 4
A 10	D A 22
B A 18 B 4	E A 12

**F** None of the other answers is correct!

Question 14 What is the result of the following SQL query?

SELECT count(T1.C1)
FROM T1
WHERE T1.C1 IN
(SELECT T2.C1
FROM T2
WHERE T2.C1="A")

- **A** 1
- **B** An empty table
- The SQL in incorrect
- **D** 2
- **E** 4
- **F** None of the other answers is correct!

**Question 15** What is the result of the following SQL query?

SELECT DISTINCT T1.C1, T1.C2, T2.C1, T2.C2 FROM T1 JOIN T2 ON T1.C1 = T2.C1 WHERE T1.C2 IN (2, 4)

A	A	2	A	2
	A	2	A	4
	В	2	A	4
	В	2	В	2

	A	1	A	4
	A	2	A	4
В	A	1	A	2
	A	2	A	2
	В	2	В	2

A 2 A

	A	2	A	2
D	A	2	A	4
,	В	2	В	2

C Empty table

F	A	2	A	2
L	A	2	A	4

F None of the other answers is correct!

**Question 16** What is the result of the following SQL query?

SELECT T1.C2, T2.C2 FROM T1 LEFT JOIN T2 ON T1.C1 = T2.C1 WHERE T1.C2 < 2 OR T1.C2 > 4

A	1	2 4
	1 NULL	NULL 5
В	1 1	2 4

F None of the other answers is correct!

NULL

## 3. Theory

**Question 17** One of the reasons normalization is needed is to eliminate Update, Insert and Delete anomalies. Considering the following relations, which of the following is true?

EMP\_PROJ(Emp#, Proj#, Ename, Pname, No\_hours)

EMP(Emp#, Ename)

PROJ(Proj#, Pname)

- A EMP\_PROJ and EMP suffer from Update and Delete anomalies.
- B EMP\_PROJ suffers from Update, Insert and Delete anomalies.
- C PROJ suffers from Update, Insert and Delete anomalies.
- D EMP suffers from Update, Insert and Delete anomalies.
- E None of these relations suffers from Update, Insert and Delete anomalies.

**Question 18** The following table shows the current state of a relation. Does the following functional dependency hold:  $C_2 \rightarrow C_3$ ?

$C_1$	$C_2$	$C_3$	$C_4$
1	1	XX	157
2	1	XX	178
3	1	XX	192
4	2	XY	183
5	2	XY	166

- $oxed{A}$  No, because values of  $C_3$  are not unique.
- B Yes, since if  $C_2$  is 1, then  $C_3$  is XX; and if  $C_2$  is 2, then  $C_3$  is XY.
- C A dependency cannot be confirmed by just checking one state of the relation.
- D None of the other choices is correct!

Consider the database below. Where, the primary keys are underlined and the foreign key (FK) relationships are:

- PROJECT.Dnum is FK ref. DEPARTMENT.Dnumber;
- PROJECT.Plocation is FK ref. DEPT LOCATIONS.Dlocation;
- DEPT\_LOCATIONS.Dnumber is FK ref. DEPARTMENT.Dnumber;
- DEPARTMENT.Mgr\_ssn is FK ref. EMPLOYEE.Ssn;
- EMPLOYEE.Super\_ssn is FK ref. EMPLOYEE.Ssn;
- EMPLOYEE.Dno is FK ref. DEPARTMENT.Dnumber.

Suppose each of the following update operations is applied directly to this database.

#### **EMPLOYEE**

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno
John	В	Smith	123456789	1965-01-09	731 Fondren, Houston, TX	М	30000	333445555	5
Franklin	Т	Wong	333445555	1955-12-08	638 Voss, Houston, TX	М	40000	888665555	5
Alicia	J	Zelaya	999887777	1968-01-19	3321 Castle, Spring, TX	F	25000	987654321	4
Jennifer	S	Wallace	987654321	1941-06-20	291 Berry, Bellaire, TX	F	43000	888665555	4
Ramesh	K	Narayan	666884444	1962-09-15	975 Fire Oak, Humble, TX	М	38000	333445555	5
Joyce	Α	English	453453453	1972-07-31	5631 Rice, Houston, TX	F	25000	333445555	5
Ahmad	V	Jabbar	987987987	1969-03-29	980 Dallas, Houston, TX	М	25000	987654321	4
James	Е	Borg	888665555	1937-11-10	450 Stone, Houston, TX	М	55000	NULL	1

#### **PROJECT**

Pname	<u>Pnumber</u>	Plocation	Dnum
ProductX	1	Bellaire	5
ProductY	2	Sugarland	5
ProductZ	3	Houston	5
Computerization	10	Stafford	4
Reorganization	20	Houston	1
Newbenefits	30	Stafford	4

## **DEPT\_LOCATIONS**

Dlocation
Houston
Stafford
Bellaire
Sugarland
Houston

### **DEPARTMENT**

Dname	<u>Dnumber</u>	Mgr_ssn	Mgr_start_date
Research	5	333445555	1988-05-22
Administration	4	987654321	1995-01-01
Headquarters	1	888665555	1981-06-19

**Question 19** Choose the correct statement regarding the integrity constraints (i.e. key constraints and referential integrity constraint) of the following operation when applied on the above database.

## Insert <'ProductA', 5, 'Bellaire', 1> into PROJECT

A No constraint violations.

B It violates the key constraint because there already exists a DEPARTMENT tuple with DNUMBER=5.

C It violates only referential integrity because DNUM=1 and there is a tuple in the DEPARTMENT relation with DNUMBER=1.
D It violates both key and referential integrity constraint.
E None of the other choices is correct.
Question 20 Choose the correct statement regarding the integrity constraints (i.e. key constraints and referential integrity constraint) of the following operation when applied on the above database.
Insert < 'Production', 3, '943775543', '1988-10-01' > into DEPARTMENT.
A No constraint violations.
B It violates only key constraint.
C It violates only referential integrity constraint.
D It violates both key and referential integrity constraints.
E None of the other choices is correct.
<b>Question 21</b> Choose the correct statement regarding the integrity constraints (i.e. key constraints and referential integrity constraint) of the following operation when applied on the above database.
Set the EMPLOYEE.Ssn attribute to '123456789' of the EMPLOYEE tuple with EMPLOYEE.Ssn= '888665555'.
A It violates only the key constraint.
B It violates only the referential integrity constraint.
C It violates both key and referential integrity constraints.
D No constraint violations.
E None of the other choices is correct.

Answer the following questions considering the following transactions and schedules.

$T_1$	$T_2$	$T_1$	$T_2$
read( $A$ ) A := A - 50 write( $A$ ) read( $B$ ) B := B + 50 write( $B$ ) commit	read( $A$ ) temp := A * 0.1 A := A - temp write( $A$ ) read( $B$ ) B := B + temp write( $B$ ) commit	read(A) $A := A - 50$ $write(A)$ $read(B)$ $B := B + 50$ $write(B)$ $commit$	read(A)

$T_1$	$T_2$	
read(A) $A := A - 50$ $write(A)$		
	read( $A$ ) temp := A * 0.1 A := A - temp write( $A$ )	
read( $B$ ) B := B + 50 write( $B$ ) commit		
	read(B) B := B + temp write(B) commit	

$T_1$	$T_2$
read(A)	
A := A - 50	
	read(A)
	temp := A * 0.1
	A := A - temp
	write(A)
	read(B)
write(A)	
read(B)	
B := B + 50	
write(B)	
commit	
	B := B + temp
	write(B)
	commit
Sche	edule D

Schedule C

Question 22 Choose the correct statement.

- A None of the other choices is correct.
- B Schedule C suffers from the lost update problem.
- C Both Schedule B and C suffer from the lost update problem.
- D Schedule D suffers from the lost update problem.

Question 23 Consider the two serial schedules A and B.

- A Schedule D is serializable to Schedule A.
- B Schedule D is serializable to Schedule B.
- C Schedule C is serializable to Schedule A.
- D Schedule C is serializable to Schedule B.
- E None of the other choices is correct!

second account. Which of the ACID properties guarantees that either both SQL statements get executed (and the money is transferred) or none does (not transferring the money at all)?
A Atomicity
B Isolation
C Durability
D Correctness
E Integrity
F None of the other choices is correct!

**Question 24** When transferring money from one bank account to another we need to run two SQL statements: one that reduces the balance of the first account and one that increases the balance of the