Uppsala University

Department of Information Technology

Database Design I (1DL301) – 2023-1-11

Instructions: Read through the whole exam paper and note any unclear directives before you start solving the questions.

This is a multiple-choice exam with two types of questions:

- If a **question is marked with ♥** you must **select ALL correct choices**. If you do not select all correct choices or you include any incorrect choice, your answer will be marked as incorrect.
- For all **other questions** you must **select only one choice** even if there are several correct choices. Your answer will be marked as correct if you select any of the correct choices. If you select an incorrect choice or select more than one choice, your answer will be marked as incorrect.

To achieve a grade of 3, you must gain at least 14 correct answers. To achieve a grade of 4, you must gain at least 17 correct answers. To achieve a grade of 5, you must collect at least 21 correct answers.

Answers must be given exclusively on the provided answer sheet; any answers given on other sheets will be ignored. If you feel you need a new clean answering sheet **please** ask for one.

If you find any questions unclear, you can leave a note explaining your concern (on the back of the answer sheet or on a separate sheet) and I will consider it.

You are allowed to use dictionaries to and from English and a calculator, but no other material.

General questions (useful for us)

Question G1 ♣ When have you attended the course?

A Period 2, 2022
B Period 1, 2022
C Period 2, 2021
D Period 1, 2021
E None of the previous answers

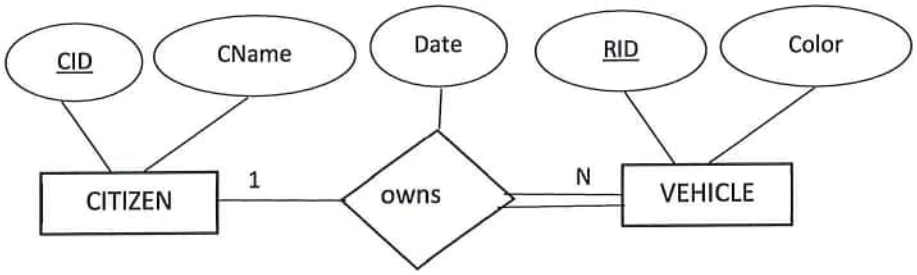
Question G2 ♣ How many lectures have you attended?

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

Question 1 ♥ For the depicted ER model, select all statements that may hold! (Select **all** correct choices)



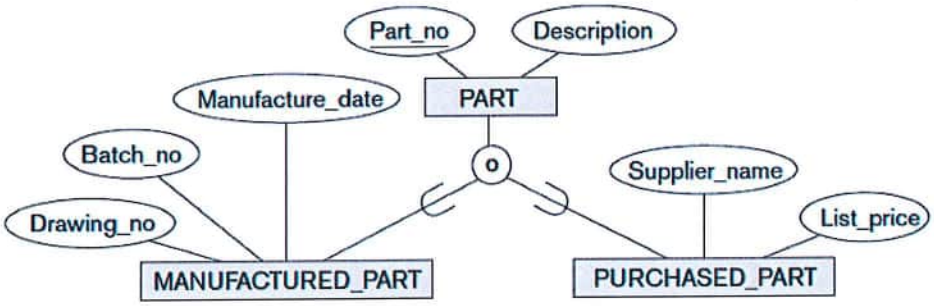
A Citizens with CIDs 12 and 13 co-own the car with registration number RID 23YYDD.

B A citizen with CID 12 owns the car with registration number RID 23YYDD since 1/1/2020.

C It is possible that a Citizen does not own a car.

D It is possible that a vehicle does not belong to any owner.

Question 2 We want to convert the following EER diagram to the relational model. Choose the MOST appropriate answer from the following.



A MANUFACTURED_PART(Part_no, Manufacture_date, Batch_no, Drawing_no, Description), PURCHASED_PART(Part_no, Supplier_name, List_price, Description)

B PART(Part_no, Description, Manufacture_date, Batch_no, Drawing_no, Supplier_name, List_price, Manufactured_part_flag, Purchased_part_flag)

C PART(Part_no, Description),
MANUFACTURED_PART(Manufacture_date, Batch_no, Drawing_no),
PURCHASED_PART(Supplier_name, List_price)

Question 3 Consider the EER model depicted in **Question 2** and the semantics of EER models. Select the correct statements from the following.

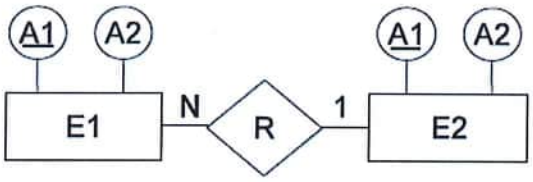
A PURCHASED_PART cannot inherit a primary key from PART.

B An entity type PART may be none of the indicated sub-classes

C An entity type PURCHASED_PART must also be a MANUFACTURED_PART

D All entity types have an attribute called "Batch_no"

Question 4 Which relational schema is the best correspondence to the following ER diagram?



A E1(A1, A2), E2(A1, A2), R(E1, E2) (with R.E1 FK ref. E1.A1 and R.E2 FK ref. E2.A1) (where FK is a foreign key)

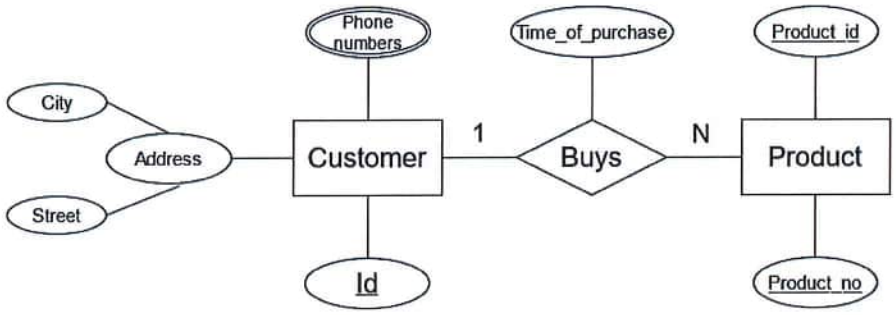
B None of the other answers

C E1(A1, A2, E2), E2(A1, A2) (with E1.E2 FK ref. E2.A1)

D E1(A1, A2), E2(A1, A2, E1) (with E2.E1 FK ref. E1.A1)

E E1(E2, A1, A2), E2(A1, A2) (with E1.E2 FK ref. E2.A1)

Question 5 Which of the following options is the best mapping of the ER diagram to the relational model? Where, Id is the key of CUSTOMER and Product_id and Product_no are two candidate keys of PRODUCT.



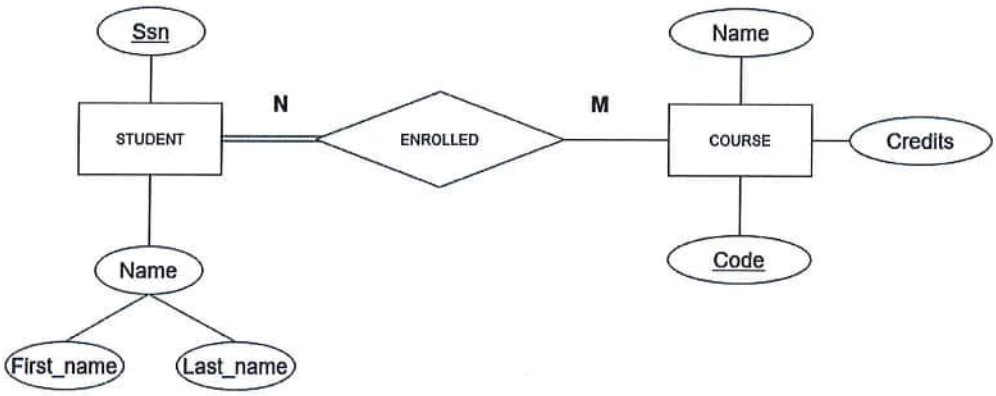
A CUSTOMER(Id, City, Street, Product_id, Product_no), with {Product_id, Product_no} $\xrightarrow{FK}$ PRODUCT({Product_id, Product_no})
PHONES(Phone_number, Id), with Id $\xrightarrow{FK}$ CUSTOMER(Id),
PRODUCT(Product_id, Product_no, Time_of_purchase) (where FK is a foreign key)

B CUSTOMER(Id, {Phone numbers}, Address, City, Street),
BUYS(Id, Product_id, Time_of_purchase), with Id $\xrightarrow{FK}$ CUSTOMER(Id) and Product_id $\xrightarrow{FK}$ PRODUCT(Product_id),
PRODUCT(Product_id, Product_no)

C CUSTOMER(Id, {Phone numbers}, Address(City, Street)),
PRODUCT(Product_id, Product_no, Customer_id, Time_of_purchase), with Cutomer_id $\xrightarrow{FK}$ CUSTOMER(Id)

D CUSTOMER(Id, City, Street),
PHONES(Phone_number, Id), with Id $\xrightarrow{FK}$ CUSTOMER(Id),
PRODUCT(Product_id, Product_no, Time_of_purchase, Buyer_id), with Buyer_id $\xrightarrow{FK}$ CUSTOMER(Id)

Question 6 We want to convert the following ER model to the relational model. Choose a valid answer.



A STUDENT(Ssn, First_name, Last_name),
COURSE(Code, Name, Credits),
ENROLLED(SSsn, Name) with Ssn $\xrightarrow{FK}$ STUDENT(Ssn) (where FK is a foreign key)

B STUDENT(Ssn, First_name, Last_name),
COURSE(Code, Name, Credits),
ENROLLED(SSsn, CCode) with SSsn $\xrightarrow{FK}$ STUDENT(Ssn) and CCode $\xrightarrow{FK}$ COURSE(Code)

C None of the other options.

D STUDENT(Ssn, First_name, Last_name, Ccode), with Ccode $\xrightarrow{FK}$ COURSE(Code),
COURSE(Code, Name, Credits)

E STUDENT(Ssn, Name, First_name, Last_name),
COURSE(Code, Name, Credits, Ssn), with Ssn $\xrightarrow{FK}$ STUDENT(Ssn)

Question 7 Consider R(A, B, C, D, E, F) which is in 1NF (at least) and the following functional dependencies hold:

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

Which of the following databases contains all the information contained in R **and has all relations in 3NF** (we do not show the primary or foreign key)?

A R1(B, C, E), R2(A, D, E ,F)

B R1(B, C), R2(E), R3(A), R4(D, F)

C R1(A, B, C, E), R2(A, D, E, F)

D R(A, B, C, D, E, F)

E R1(B, C, E), R2(A, E), R3(A, D, F)

Question 8 ♥ Consider a relation R(A, B, C, D, E, F, G) in 1NF where the following functional dependencies hold:

- $\{B, C\} \rightarrow \{E\}$
- $\{E\} \rightarrow \{A\}$
- $\{A\} \rightarrow \{D, F\}$
- $\{G\} \rightarrow \{E\}$

Which of the following are candidate keys of R? (Select **all** correct choices)

A {B, C}

B There are no candidate keys.

C {G}

D {A, B, D, F}

E {C}

By considering the following database, **answer questions 9-16**.

T1		
C1	C2	C3
a	x	1
a	y	5
b	z	2
a	y	2
d	u	3

T2		
C1	C2	C3
a	z	4
a	x	2
b	z	2
b	x	5
c	u	2

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

```
SELECT Count(*)
FROM T1, T2
WHERE T1.C2=T2.C2
```

A 5

B 0

C The SQL is incorrect

D 7

E None of the other answers is correct!

F 16

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

```
SELECT COUNT(*)
FROM T1, T2
WHERE  T1.C3>T2.C3
```

A 10

B 0

C The SQL is incorrect

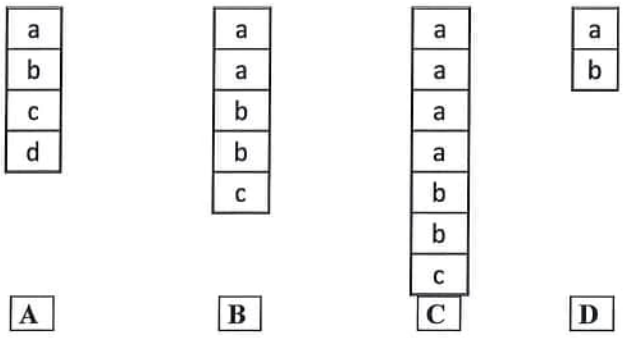
D 7

E None of the other answers is correct!

F 16

Question 11 What is the result of the following SQL query?

```
SELECT DISTINCT T1.C1
FROM T1, T2
WHERE T1.C1=T2.C1
```

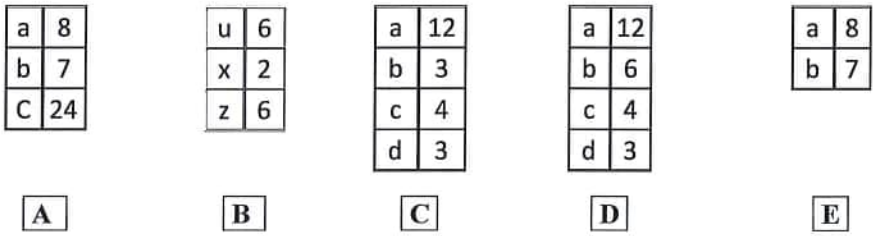


A	B	C	D
a	a	a	a
b	a	a	b
c	b	a	
d	b	a	
	c	b	
		b	
		c	

E None of the other answer is correct!

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

```
SELECT T1.C1, AVG(T1.C3*T2.C3)
FROM T1, T2
WHERE T1.C1 = T2.C1
GROUP BY T1.C1
```



A		B		C		D		E	
a	8	u	6	a	12	a	12	a	8
b	7	x	2	b	3	b	6	b	7
C	24	z	6	c	4	c	4		
				d	3	d	3		

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

```
SELECT T1.C2, SUM(T1.C3*T2.C3)
FROM T1, T2
WHERE T1.C2 = T2.C2
GROUP BY T1.C2
```

u 6 x 7 z 12	x 7 y 35 z 10	z 12	a 19	a 24
A	B	C	D	E

F None of the other answers is correct!

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

```
SELECT count(*)
FROM T1 LEFT OUTER JOIN T2 ON (T1.C1 = T2.C1)
```

A 1

B An empty table

C The SQL is incorrect

D 8

E 9

F None of the other answers is correct!

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

```
SELECT T2.C1
FROM T1 INNER JOIN T2 ON (T1.C1 = T2.C1)
WHERE (T1.C3>1)
```

A.	B.	C.	D.
a	a	y	a
a	a	Y	a
a	b		NULL
a			NULL
b			
b			

E None of the other answers is correct!

Question 16 What is the result of the following SQL query (disregard the order)?

```
SELECT T2.C2
FROM T1 LEFT OUTER JOIN T2 ON (T1.C2 = T2.C2)
```

A	B	C	D
z	z	x	x
x	x	z	NULL
z	z	u	z
x	x		u
u	u		
NULL			
NULL			

Question 17 Consider the relation **R(A, B, C, D, E, F)** with {A, B} as a composite primary key and the following dependencies:

- {A, B}→ C, D, E
- A→ F

Which of the following options is true?

[A] R is in 3NF (i.e. 3rd Normal Form)

[B] R is in 2NF (i.e. 2nd Normal Form)

[C] R is in 1NF (i.e. 1st Normal Form)

[D] R is in 3NF but not in 2NF

Question 18 If a table T has 10 rows, the SQL instruction "delete from T":

[A] None of the other answers

[B] May delete more than 10 rows from T

[C] Always deletes the 10 rows, but does not remove the table from the database schema

[D] Removes the table from the database schema (and as a consequence also the 10 rows)

[E] May delete less than 10 rows because of referential integrity constraints

[F] The SQL is incorrect

Question 19 ♥ The following table shows the current state of a relation, where C_1 is the **key** of the relation. Which of the following options are correct? (Select **all** correct choices)

C_1	C_2	C_3	C_4
1	1	George	Anna
2	1	George	Anna
3	1	John	Anna
4	2	John	Nektarios
5	2	John	Marina
6	3	Marina	Marina

[A] The functional dependency $C_1 \rightarrow C_2$ holds.

[B] The functional dependency $C_1 \rightarrow C_3$ holds.

[C] We cannot be certain whether the functional dependency $C_2 \rightarrow C_3$ holds.

[D] We cannot be certain whether the functional dependency $C_2 \rightarrow C_3$ does not hold.

[E] The functional dependency $C_2 \rightarrow C_4$ does not hold.

[F] The functional dependency $C_3 \rightarrow C_4$ may hold.

By considering the database below, **answer questions 20-22**. 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	B	Smith	123456789	1965-01-09	731 Fondren, Houston, TX	M	30000	333445555	5
Franklin	T	Wong	333445555	1955-12-08	638 Voss, Houston, TX	M	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	M	38000	333445555	5
Joyce	A	English	453453453	1972-07-31	5631 Rice, Houston, TX	F	25000	333445555	5
Ahmad	V	Jabbar	987987987	1969-03-29	980 Dallas, Houston, TX	M	25000	987654321	4
James	E	Borg	888665555	1937-11-10	450 Stone, Houston, TX	M	55000	NULL	1

PROJECT

Pname	Pnumber	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

Dnumber	Dlocation
1	Houston
4	Stafford
5	Bellaire
5	Sugarland
5	Houston

DEPARTMENT

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

Question 20 Choose the correct statement regarding the constraints of the following operation when applied on the above database.

Insert <'ProductA', 4, 'Bellaire', 2 > into PROJECT

A No constraint violations.

B It violates only the key constraint.

C It violates only the referential integrity constraint.

D It violates both key and referential integrity constraints.

Question 21 Choose the correct statement regarding the constraints of the following operation when applied on the above database.

Insert < NULL, 4, '777889999', '1988-05-22' > into DEPARTMENT.

A No constraint violations.

B It violates only the key constraint.

C It violates only the referential integrity constraint.

D It violates both key and referential integrity constraints.

E It violates only the entity integrity constraint.

Question 22 Choose the correct statement regarding the constraints of the following operation when applied on the above database.

Set the EMPLOYEE.Dno attribute to '1' of the EMPLOYEE tuple with EMPLOYEE.Ssn= '999887777'.

A It violates only the key constraint.

B It violates only the referential integrity.

C It violates both key and referential integrity.

D It violates only the entity integrity constraint.

E No constraint violations.

Question 23 ♥ Considering the following transactions and schedules, which of the following are correct? (Select **all** correct choices)

T1	T2	T3
	read_item(A);	
	A := A + 10;	
		read_item(C);
		C := C / 10;
		write_item(C);
		read_item(A);
read_item(A);		
A := A * 5;		
write_item(A);		
read_item(B);		
B := B - 10;		
write_item(B);		
	write_item(A);	
		A := A / 5;
		write_item(A);

Schedule A

T1	T2	T3
read_item(A);		
A := A * 5;		
write_item(A);		
	read_item(A);	
read_item(B);		
B := B - 10;		
write_item(B);		
	A := A + 10;	
		read_item(C);
		C := C / 10;
		write_item(C);
	write_item(A);	
		read_item(A);
		A := A / 5;
		write_item(A);

Schedule B

T1	T2	T3
read_item(A);		
		read_item(C);
A := A * 5;		
		C := C / 10;
write_item(A);		
	read_item(A);	
	A := A + 10;	
	write_item(A);	
read_item(B);		
B := B - 10;		
		write_item(C);
		read_item(A);
		A := A / 5;
write_item(B);		
		write_item(A);

Schedule C

T1	T2	T3
read_item(A);		
A := A * 5;		
write_item(A);		
read_item(B);		
B := B - 10;		
write_item(B);		
	read_item(A);	
	A := A + 10;	
	write_item(A);	
		read_item(C);
		C := C / 10;
		write_item(C);
		read_item(A);
		A := A / 5;
		write_item(A);

Schedule D

A Schedule A suffers from the lost update problem

B Schedule B suffers from the lost update problem

C Schedule C suffer from the lost update problem

D Schedule D suffers from the lost update problem

Question 24 Considering the following transactions and schedules and the following Precedence graphs, which of the following is true?

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

Schedule A

T_1	T_2
	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	

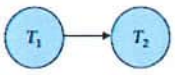
Schedule B

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

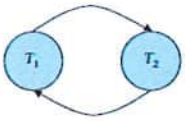
Schedule C

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

Schedule D



Precedence Graph A1



Precedence Graph B1

A. Precedence graph A1 corresponds to Schedule C.

B. Precedence graph B1 corresponds to Schedule C.

C. Precedence graph A1 corresponds to Schedule A, B and C.

D. None of the other answers is correct!