

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

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

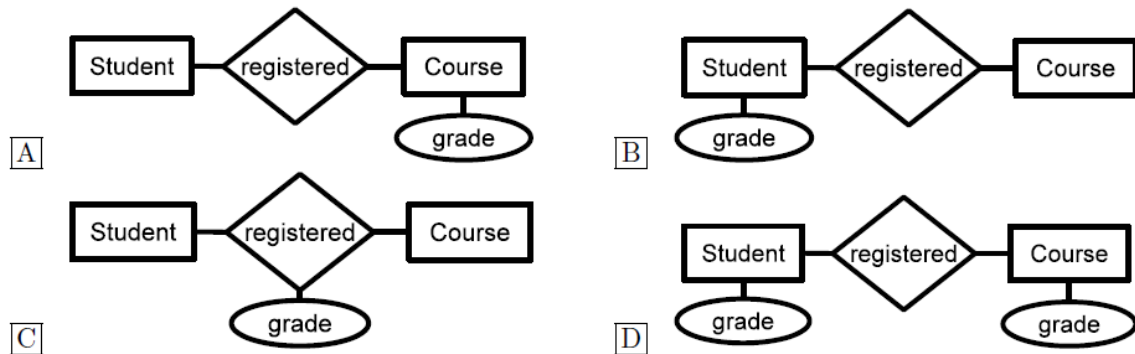
- A None or very few
- B Around 25%
- C Around 50%
- D Around 75%
- E Almost all

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

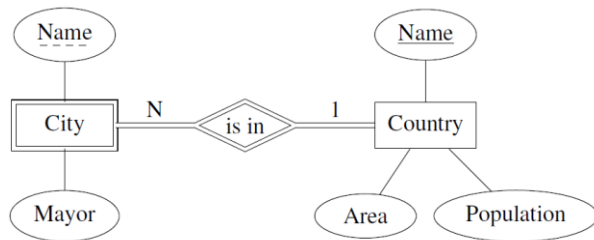
- A F
- B STS
- C CS
- D X
- E IT
- F None of the previous answers

## 1. Database design

**Question 1** Consider the scenario where a student can attend many courses and many students can attend a course. We want to record the grades of a student for each course. Which of the following ER diagrams is correct? (only a portion of the diagram has been visualized)!

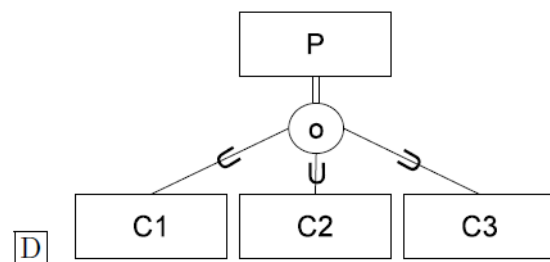
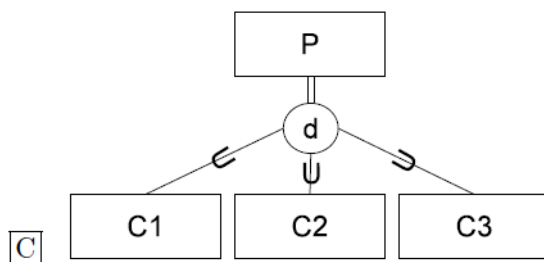
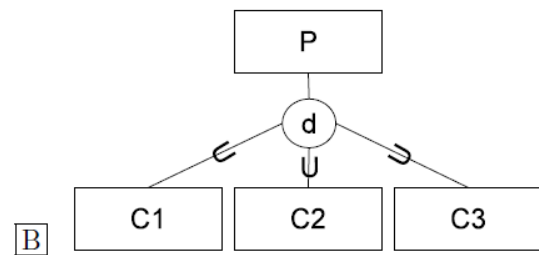
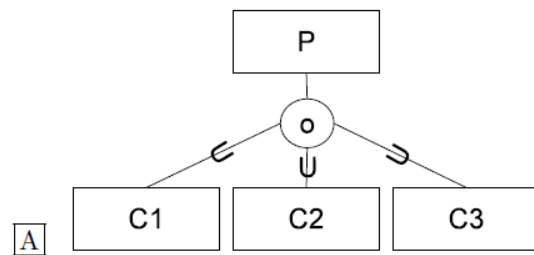


**Question 2** Which of the following statements about the depicted ER model is correct?

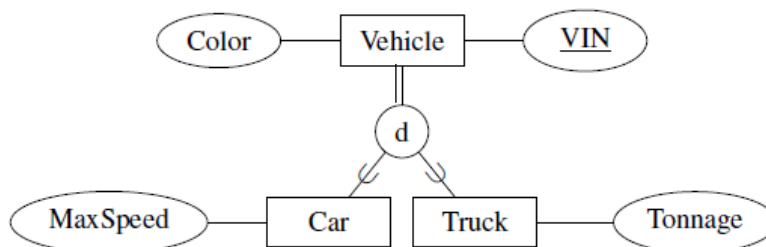


- A** Same person cannot be mayor of two cities.
- B** Each city is exactly in one country.
- C** The population of a country is always larger than 0.
- D** No two countries have exactly the same area and population.
- E** The name of a city must be different from the name of a country.

**Question 3** Entity type P can be either only one type of C1, C2, C3 types or none of them. Namely, it cannot belong to more than one types at the same time. However, it can belong to none of them. Which of the following ER diagrams corresponds to these specifications? (only a portion of the diagram has been visualized)



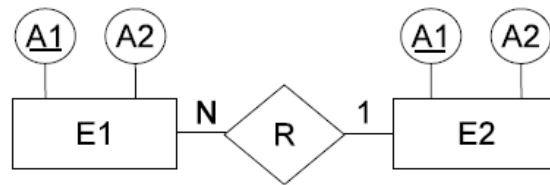
**Question 4** Consider we want to convert the following diagram to the relational model. Which of the following is the best answer?



:

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

**Question 5** Which relational schema corresponds to the following ER diagram (where, underlined attributes represent a key)?



- ☐ A E1(A1, A2), E2(A1, A2), R(E1, E2) (with R.E1 FK ref. E1.A1 and R.E2 FK ref. E2.A1)
- ☐ 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 6** Consider a relation in 1NF R(A, B, C, D, E) with {A, B} as a composite primary key and the following dependencies:

- {A, B} → C, D, E
- C → E

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 (i.e. 1<sup>st</sup> Normal Form)
- ☐ C R is in 1NF but not in 2NF
- ☐ D R is in 2NF but not in 3NF

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 (but not a unique name). Each staff member has a unique Staff No, Name and Grade and can work on many projects for a number of days.

<b><u>Staff Allocation Sheet</u></b>			
<b>Project Code:</b> 3411		<b>Project Description:</b> New Accounts	
<b>Customer Number:</b> 3475		<b>Customer Name:</b> 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}
- ☐ C Customer Name → Customer Number; Staff No→{Name, Grade}
- ☐ D None of the other answers

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

PROJECT(Project Code, 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.

T1

C1	C2
A	B
A	C
B	A
A	C

T2

C1	C2
A	C
A	D
B	B
D	C

**Question 9** What is the result of the following SQL query (showing only the content)?

**SELECT T1.C1  
FROM T1**

- ☐ A 

A
A
B
A
- ☐ B An empty table
- ☐ C 

A
B
- ☐ D 

A	3
B	1
- ☐ E The SQL is incorrect

**Question 10** What is the result of the following SQL query (showing only the content)?

**SELECT T2.C1  
FROM T2  
WHERE (C2="D" OR C2="B")**

- ☐ A 

A
A
B
A
- ☐ B An empty table
- ☐ C 

A
B
- ☐ D 

A	3
B	1
- ☐ E The SQL is incorrect

**Question 11** What is the result of the following SQL query (showing only the content)?

```
SELECT T1.C1, T2.C2
FROM T1 Join T2 on T1.C1=T2.C1
WHERE T1.C2=T2.C2
```

☐ A

A	C
A	D
A	C

☐ B

A	C
A	C

☐ C The SQL is incorrect

☐ D

A	C
A	D
B	B
A	C

☐ E

A	C
---	---

☐ F An empty table

☐ G None of the other answers

**Question 12** What is the result of the following SQL query (showing only the content)?

```
SELECT T1.C1, count(T2.C2)
FROM T1 Join T2 on T1.C1=T2.C1
WHERE T1.C2=T2.C2
GROUP BY T1.C1
```

☐ A The SQL is incorrect

☐ B An empty table

☐ C

A	4
B	1
C	1

☐ D

A	1
B	1

☐ E

A	1
B	2

☐ F None of the other answers

☐ G

A	2
B	1

**Question 13** What is the result of the following SQL query? (showing only the content)

```
SELECT count(T1.C1)
FROM T1
WHERE T1.C1 IN
      (SELECT T2.C1
       FROM T2
       WHERE T2.C2="B")
```

☐ A 1

☐ B An empty table

☐ C The SQL is incorrect

☐ D 2

☐ E 4

☐ F None of the other answers is correct!

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

```
SELECT count(*)  
FROM T1, T2
```

- ☐ **A** 4
- ☐ **B** An empty table
- ☐ **C** The SQL is incorrect
- ☐ **D** None of the other answers is correct!
- ☐ **E** 8
- ☐ **F** 16



Consider the following tables.

STUDENTS		
Student_ID	Stud_Name	Adv_ID
1	Nektarios	1
2	George	8
3	Anna	2
4	Iliada	3
5	Ioanikios	3
6	Chrys	1
7	Marina	3

ADVIDORS	
Advisor_ID	Adv_Name
1	Chris
3	Maria
5	Kypriani

**Question 15** What is the result of the following SQL query? (showing only the content)

```
SELECT Stud_Name, Adv_Name
FROM
    STUDENTS LEFT OUTER JOIN ADVISORS
    ON Advisor_ID=Adv_ID
```

**A**

Stud_Name	Adv_Name
Nektarios	Chris
George	NULL
Anna	NULL
Iliada	Maria
Ioanikios	Maria
Chrys	Chris
Marina	Maria

**B**

Stud_Name	Adv_Name
Nektarios	Chris
Iliada	Maria
Ioanikios	Maria
Chrys	Chris
Marina	Maria

**C**

Stud_Name	Adv_Name
Nektarios	Chris
Iliada	Maria
Ioanikios	Maria
Chrys	Chris
Marina	Maria
NULL	Kypriani

**D**

Stud_Name	Adv_Name
Nektarios	Chris
Iliada	Maria
Chrys	Chris

**Question 16** What is the result of the following SQL query? (showing only the content)

```
SELECT Stud_Name, Adv_Name
FROM
    STUDENTS INNER JOIN ADVISORS
    ON Advisor_ID=Adv_ID
```

A

Stud_Name	Adv_Name
Nektarios	Chris
George	NULL
Anna	NULL
Iliada	Maria
Ioanikios	Maria
Chrys	Chris
Marina	Maria

B

Stud_Name	Adv_Name
Nektarios	Chris
Iliada	Maria
Ioanikios	Maria
Chrys	Chris
Marina	Maria

C

Stud_Name	Adv_Name
Nektarios	Chris
Iliada	Maria
Ioanikios	Maria
Chrys	Chris
Marina	Maria
NULL	Kypriani

D

Stud_Name	Adv_Name
Nektarios	Chris
Iliada	Maria
Chrys	Chris

### 3. Theory

**Question 17** 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 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

- ☐ 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!

**Question 19** One of the reasons normalization is needed is to eliminate Update, Insert and Delete anomalies. Considering the following relation, which of the following is true?

EMP\_PROJ(Emp#, Proj#, Emp\_name, Emp\_Address, Proj\_name, Proj\_Strat, No\_hours)

- ☐ A This relation suffers from the Delete anomaly. For instance, if we have an employee working only on ONE project and we need to delete the respective tuple, at the same time we also delete employee's details.
- ☐ B This relation does not suffer from the Insert anomaly; as we can easily add the details of a new employee in the database at any time.
- ☐ C This relation does not suffer from any anomaly (Update, Insert or Delete anomalies).
- ☐ D This relation has only an Update anomaly but not Delete or Insert anomalies.

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

- PROJECT.Dnum is FK ref. DEPARTMENT.Dnumber;
- 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	<u>Ssn</u>	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	<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

<u>Dnumber</u>	<u>Dlocation</u>
1	Houston
4	Stafford
5	Bellaire
5	Sugarland
5	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 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 <'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 21** 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', 4, '333445555', '01-OCT-88' > into DEPARTMENT.**

- ☐ A No constraint violations.
- ☐ B It violates only key constraint
- ☐ C It violates only referential integrity constrain
- ☐ D It violates both key and referential integrity constraint.

**Question 22** 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.Super\_ssn attribute to '943775543' of the EMPLOYEE tuple with EMPLOYEE.Ssn= '999887777'.**

- ☐ A It violates the key constraint.
- ☐ B It violates the referential integrity. We may enforce the constraint by: (i) rejecting the operation, or (ii) by inserting a new EMPLOYEE tuple with SSN='943775543'.
- ☐ C It violates the referential integrity. We may enforce the constraint by changing the SSN='943775543'.
- ☐ D It does not violate the referential integrity.

Answer the following questions considering the following transactions and schedules.

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

**Schedule A**

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

**Schedule B**

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

**Schedule C**

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

**Schedule D**

**Question 23** 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 24** Which of the following are ACID properties?

- ☐ A Independence, Dependability, Aggregation
- ☐ B Independence, Dependability, Atomicity
- ☐ C Isolation, Dependability, Atomicity
- ☐ D Isolation, Durability, Atomicity
- ☐ E Isolation, Dependability, Aggregation