

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 the answers (remember to fill in your exam code). An English explanatory dictionary and/or a translation dictionary between English and your mother tongue. You are also allowed to use a calculator.

General questions (useful for us)

Question G1 ♣ When have you attended the course?

- A Period 2, 2017
- B Period 1, 2017
- C Period 2, 2016
- D Period 1, 2016
- E Period 2, 2015
- F None of the previous answers

Question G2 ♣ How many lectures have you attended?

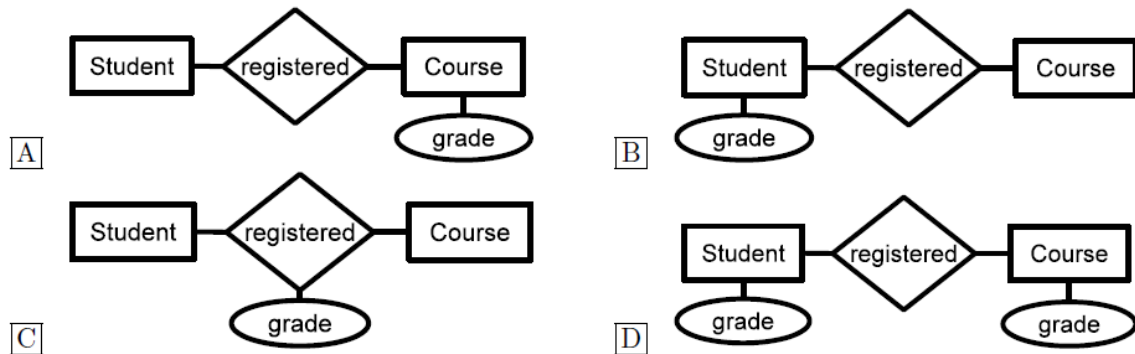
- A None or very few
- B Around 25%
- C Around 50%
- D Around 75%
- E Almost all

Question G3 ♣ What is your study program?

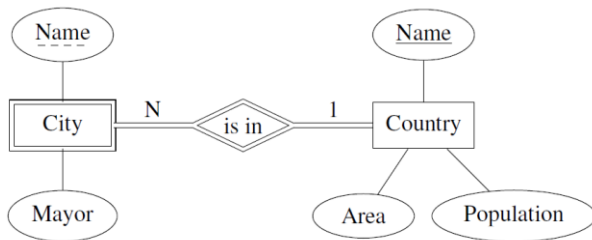
- A F
- B STS
- C CS
- D X
- E IT
- F None of the previous answers

1. Database design

Question 1 Consider the scenario where a student can attend only one course 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)!

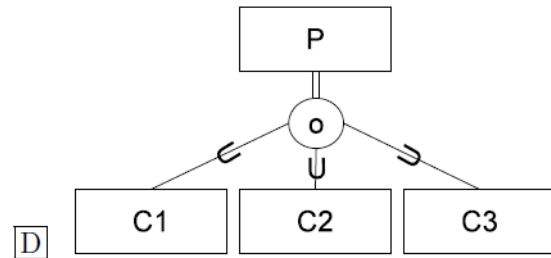
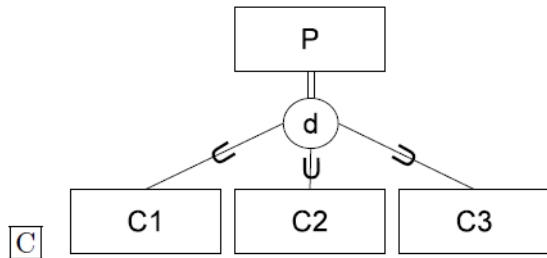
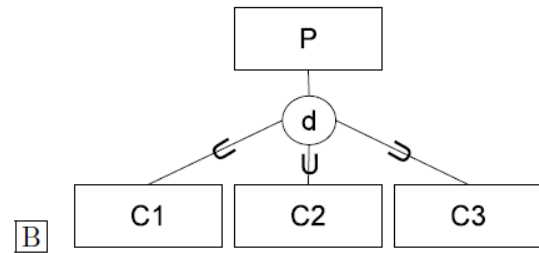
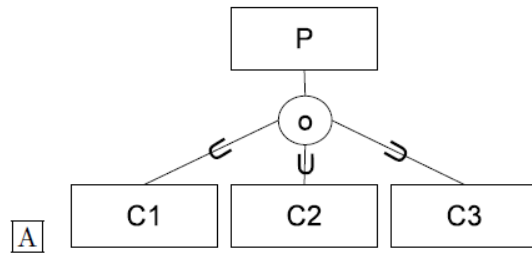


Question 2 Which of the following statements about the depicted ER model is correct?

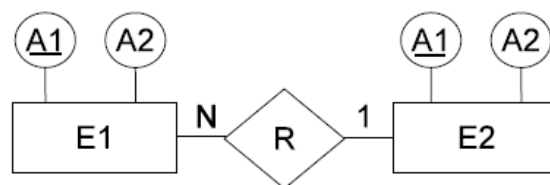


- A** Same person cannot be mayor of two cities.
- B** Each city is exactly in one country.
- C** The population of a country is always larger than 0.
- D** No two countries have exactly the same area and population.
- E** The name of a city must be different from the name of a country.

Question 3 Entity type P can be 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 Which relational schema corresponds to the following ER diagram?



- A** $E1(\underline{A1}, A2), E2(\underline{A1}, A2), R(\underline{E1}, \underline{E2})$ (with $R.E1$ FK ref. $E1.A1$ and $R.E2$ FK ref. $E2.A1$)
- B** $E1(\underline{A1}, A2), E2(\underline{A1}, A2), R(E1, \underline{E2})$ (with $R.E1$ FK ref. $E1.A1$ and $R.E2$ FK ref. $E2.A1$)
- C** None of the other answers
- D** $E1(\underline{A1}, A2, E2), E2(\underline{A1}, A2)$ (with $E1.E2$ FK ref. $E2.A1$)
- E** $E1(A1, A2), E2(A1, A2, E1)$ (with $E2.E1$ FK ref. $E1.A1$)
- F** $E1(\underline{E2}, \underline{A1}, A2), E2(\underline{A1}, A2)$ (with $E1.E2$ FK ref. $E2.A1$)

Question 5 Consider the relation $R(\underline{A}, \underline{B}, \underline{C}, D, E, F)$ with $\{A, B, C\}$ as a composite primary key and the following dependencies:

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

Which of the following is true?

- A** R is in 3NF but not in 2NF
- 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

Consider the following Student data record. Where, a Reg# is the unique registration number of a student; a Module code is a unique code of a module; a Project code is a unique code of a project (a project can be carried out by only one student and a student can carry out only one project).

Student Name: Geoff Crane		Reg #: 123456789
Course: Biochemistry		Year: 3
Module Code	Module Name	
GN 301 GN 302 GN 303 . . . etc	Introduction to Genetic Engineering Advanced Genetic Engineering Social Consequences of Genetic Eng . . . etc	
Project Details		
Project Code: PR370/94		
Project Title: Building a Group of Friends		
Project Supervisor: Frank N. Stein		

Question 6 Which of the following functional dependencies are true?

- ☐ A Reg# → Course; {Reg#, Module Code} → Module Name
- ☐ B Reg# → Project Code; Project Code → Project Title; Module Code → Project Code
- ☐ C Project Code → {Project Title, Project Supervisor}; {Reg#, Module Code} → Module Name
- ☐ D Student Name → Reg#; Project Code → Project Title; Module Code → Module Name
- ☐ E None of the other answers

Question 7 Considering the above Student record and the following relations:

STUDENT (Reg#, Course, Year, Student Name, Project Code, Project Title, Project Supervisor)

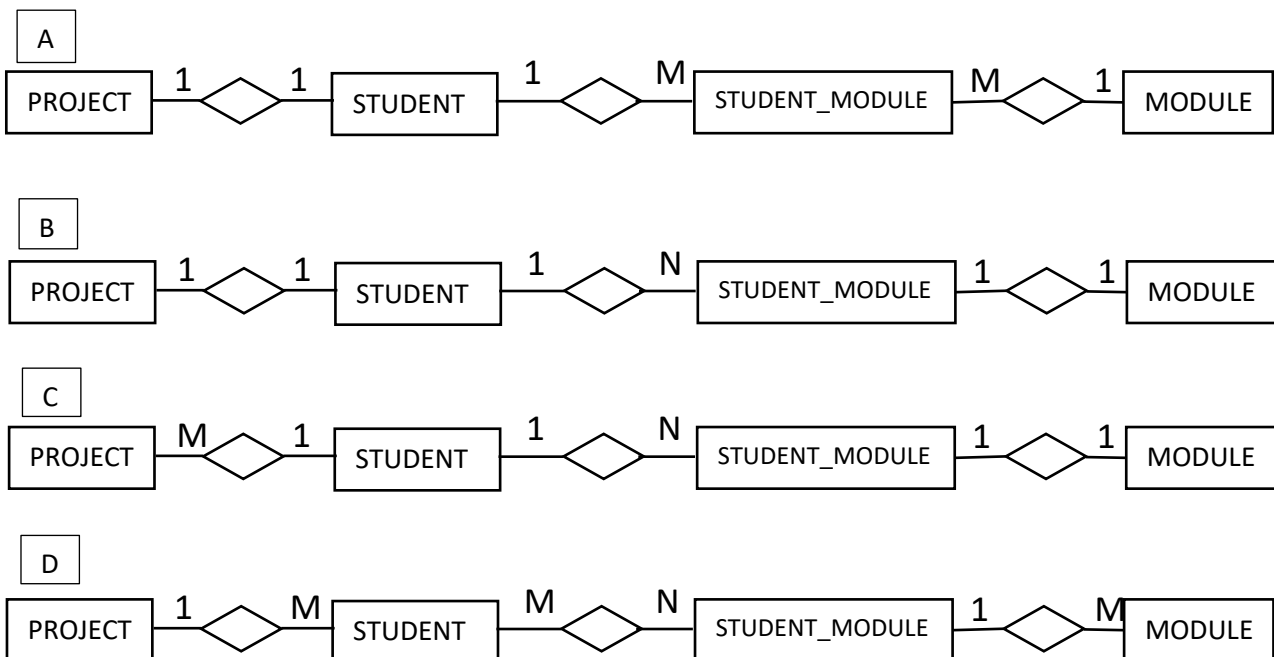
STUDENT_MOD (Reg#, Module Code)

MODULE (Module Code, Module Name)

Which of the following is true?

- ☐ A None of the other answers
- ☐ B STUDENT and STUDENT_MOD are both in 3NF
- ☐ C STUDENT is in 3NF and STUDENT_MOD is 2NF
- ☐ D STUDENT is in 3NF and STUDENT_MOD is in 1NF
- ☐ E STUDENT_MOD and MODULE are both in 3NF

Question 8 Considering the above Student record, which of the following physical ER diagrams is correct:



2. SQL

Consider the following database.

T1		T2	
C1	C2	C1	C2
A	B	A	C
A	C	A	D
B	A	B	B
A	C	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 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
```

- ☐ A An empty table
☐ B 16
☐ C

6
4
4
2

☐ D The SQL is incorrect
- ☐ E 8
☐ F 2
☐ G 4

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.C2="C")
```

- ☐ A 1
- ☐ B An empty table
- ☐ C The SQL is incorrect
- ☐ D 2
- ☐ E 4
- ☐ F 3

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

```
SELECT *
FROM T1, T2
```

- ☐ A 4
- ☐ B An empty table
- ☐ C The SQL is incorrect
- ☐ D 2
- ☐ 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 16 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

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#, No_hours)

EMP(Emp#, Ename)

PROJ(Proj#, Pname, EMPname)

Where, PROJ.EMPName is the name of the employee participating in the project, i.e. EMP.Ename

- ☐ 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 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

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

- PROJECT.Dnum FK ref. DEPARTMENT.Dnumber;
- PROJECT.Plocation FK ref. DEPT_LOCATIONS.Dlocation;
- DEPT_LOCATIONS.Dnumber FK ref. DEPARTMENT.Dnumber;
- DEPARTMENT.Mgr_ssn FK ref. EMPLOYEE.Ssn;
- EMPLOYEE.Super_ssn FK ref. EMPLOYEE.Ssn;
- EMPLOYEE.Dno 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 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', 1, 'Bellaire', 2 > into PROJECT

☐ A No constraint violations.

☐ B It violates the key constraint because there already exists a DEPARTMENT tuple with DNUMBER=4.

☐ C It violates only referential integrity because DNUM=2 and there is no tuple in the DEPARTMENT relation with DNUMBER=2.

☐ D It violates both key and referential integrity constraints.

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', '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 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.

Set the EMPLOYEE.Super_ssn attribute to '243775543' 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='243775543'.

☐ C It violates both key and referential integrity.

☐ D It does not violate the referential integrity.

Answer the following questions considering the following transactions and schedules.

T_1	T_2
$\text{read_item}(X);$ $X := X - N;$ $\text{write_item}(X);$ $\text{read_item}(Y);$ $Y := Y + N;$ $\text{write_item}(Y);$	$\text{read_item}(X);$ $X := X + M;$ $\text{write_item}(X);$

Schedule A

T_1	T_2
$\text{read_item}(X);$ $X := X - N;$ $\text{write_item}(X);$ $\text{read_item}(Y);$ $Y := Y + N;$ $\text{write_item}(Y);$	$\text{read_item}(X);$ $X := X + M;$ $\text{write_item}(X);$

Schedule B

T_1	T_2
$\text{read_item}(X);$ $X := X - N;$ $\text{write_item}(X);$ $\text{read_item}(Y);$ $Y := Y + N;$ $\text{write_item}(Y);$	$\text{read_item}(X);$ $X := X + M;$ $\text{write_item}(X);$

Schedule C

T_1	T_2
$\text{read_item}(X);$ $X := X - N;$ $\text{write_item}(X);$ $\text{read_item}(Y);$ $Y := Y + N;$ $\text{write_item}(Y);$	$\text{read_item}(X);$ $X := X + M;$ $\text{write_item}(X);$

Schedule D

Question 22

- ☐ A Schedule C and Schedule D suffer from the temporary update problem (dirty read)
- ☐ B Schedule C suffers from the lost update problem
- ☐ C Schedule B and C suffer from the lost update problem
- ☐ D Schedule D suffers from the temporary update problem (dirty read)
- ☐ E Schedule D suffers from the lost update problem

Question 23 Consider the two serial schedules A and B.

- ☐ A Schedule C is serializable to Schedule B AND Schedule D is serializable to Schedule A
- ☐ B Schedule C is serializable to Schedule A AND Schedule D is serializable to Schedule B
- ☐ C Schedule D is serializable to Schedule B
- ☐ D Schedule D is serializable to Schedule A

Question 24 Which of the following are ACID properties?

- ☐ A Independence, Dependability, Aggregation
- ☐ B Isolation, Durability, Atomicity
- ☐ C None of the other answers is true
- ☐ D Independence, Dependability, Atomicity
- ☐ E Isolation, Dependability, Atomicity
- ☐ F Isolation, Dependability, Aggregation