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.

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
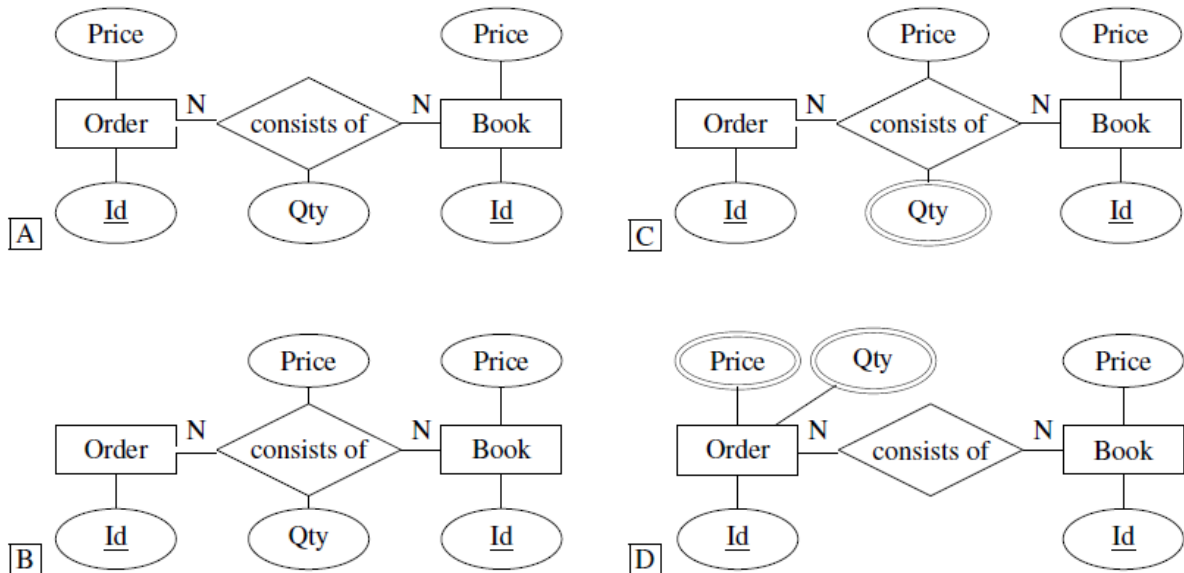
Question G2 ♣ How many lectures have you attended?
A   None or very few
B   Around 25%
C   Around 50%
D   Around 75%
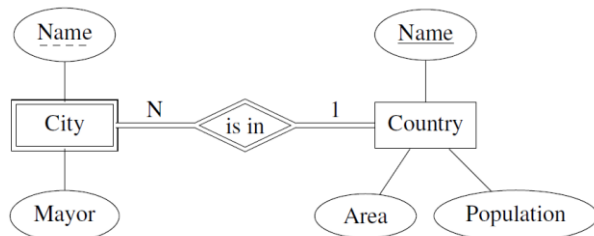E   Almost all

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.)

A — Price — Order (Id) — N — consists of — N (Qty) — N — Book (Id) — Price

B — Order (Id) — N — consists of (Price) — N — Book (Id) — Price; Qty

C — Price — Order (Id) — N — consists of — N (Qty, double oval) — N — Book (Id) — Price

D — Order (Id) — N — consists of — N — Book (Id) — Price; Price (double), Qty (double)

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

Name (dashed) — City — N — is in — 1 — Country — Name; City — Mayor; Country — Area, Population

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 o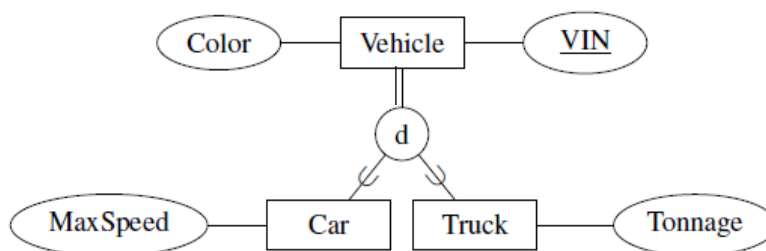f them. Which of the following EER diagrams corresponds to these specifications? (only a portion of the diagram has been visualized)!

A

P

o

C1   C2   C3

B

P

d

C1   C2   C3

C

P

d

C1   C2   C3

D

P

o

C1   C2   C3
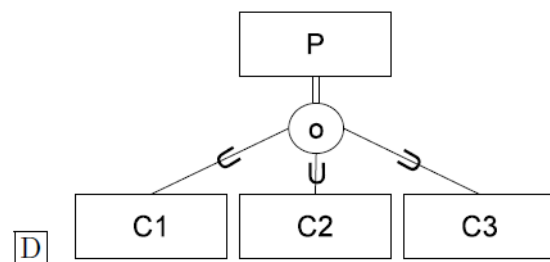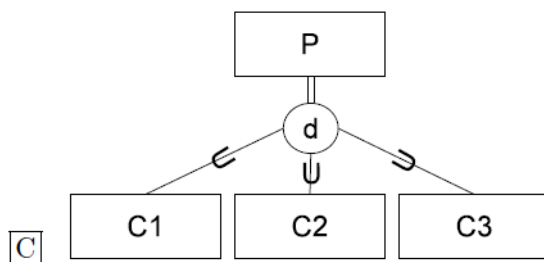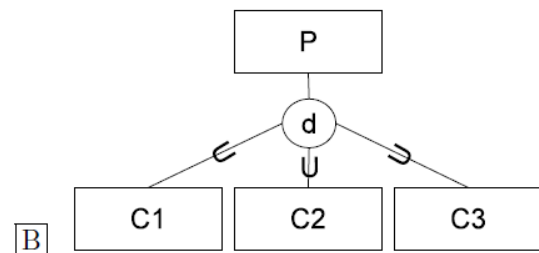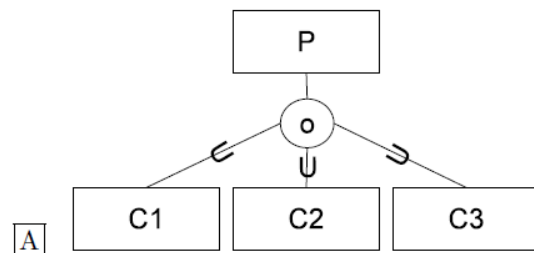
**Question 4** Consider we want to convert the following diagram to the relational model. Which of the following is the best answer?

Color — Vehicle — VIN

d

MaxSpeed — Car   Truck — Tonnage

:

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 Convert the following ER model to a relational model.
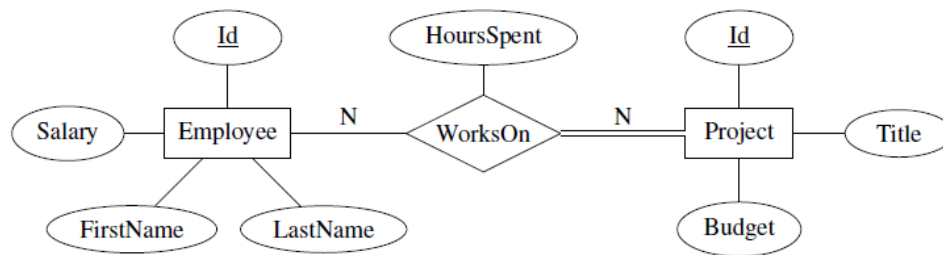
A Employee(<u>Id</u>, FirstName, LastName, Salary, WorksOnId) with WorksOnId ^{FK}→WorksOn(Id)
Project(<u>Id</u>, Title, Budget, WorksOnId) with WorksOnId ^{FK}→WorksOn(Id)
WorksOn(<u>Id</u>, HoursSpent)

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, Pid,</u> 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(<u>Eid, Pid,</u>) with Eid ^{FK}→Employee(Id) and Pid ^{FK}→Project(Id)

E None of the other answers is correct!

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

Which of the following is true?

A R is in 3NF (i.e. 3rd Normal Form) but not in 2NF (i.e. 2nd 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}

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. 2nd Normal Form)!

C All relations are in 3NF (i.e. 3rd Normal Form)!

D All relations are at least in 1NF (i.e. 1st Normal Form)!.

2. SQL

Consider the following database.

T1			T2	
C1	C2		C1	C2
A	1		A	4
A	2		A	2
B	2		B	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
B	0
C	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

A
A
A
B
A

B An empty table

C
A
B

D
A	3
B	1

E The SQL is incorrect

F None of the other answers is correct!

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

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

A
A
A
B
A

B   An empty table

C
A
B

D
A	3
B	1

E   The SQL 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

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

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

C   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
B	2	A	4
B	2	B	2

C   Empty table

B

A	1	A	4
A	2	A	4
A	1	A	2
A	2	A	2
B	2	B	2

D

A	2	A	2
A	2	A	4
B	2	B	2

E

A	2	A	2
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
1	4
1	NULL
NULL	5

B

1	2
1	4
1	NULL

C

1	2
1	4

D

NULL	5

E   Empty table

F   None of the other answers is correct!

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

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	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 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.

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.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
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)	
$A := A - 50$	
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 C

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 D

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!

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 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!