

Uppsala University

Department of Information Technology

Database Design I (1DL300) – 2020/10/19

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.

General questions (useful for us)

Question G1 ♣ When have you attended the course?

- A Period 1, 2020
- B Period 1, 2019
- C Period 2, 2018
- D Period 1, 2018
- E Period 2, 2017
- F None of the previous answers

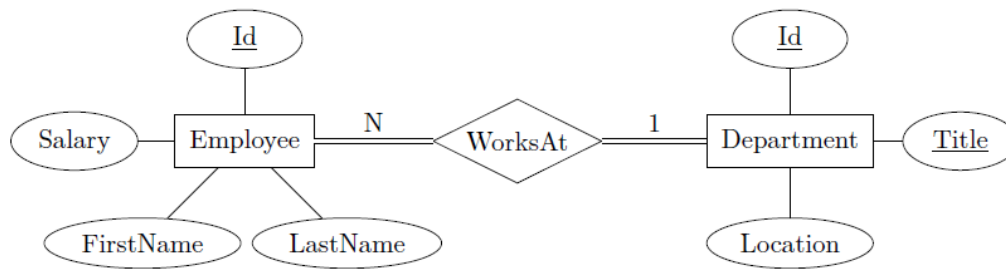
Question G2 ♣ How many lectures have you attended?

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

Question G3 ♣ What is your study program?

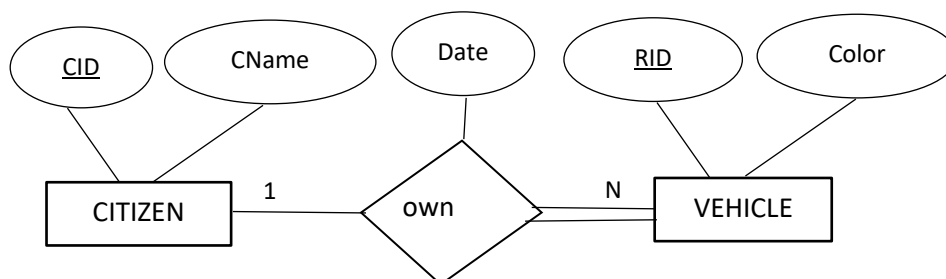
- A F
- B STS
- C CS
- D X
- E IT
- F None of the previous answers

Question 1 ♥ Based on the ER model depicted below and the semantics of ER models, which of the following statements are correct? (Select **all** correct choices)



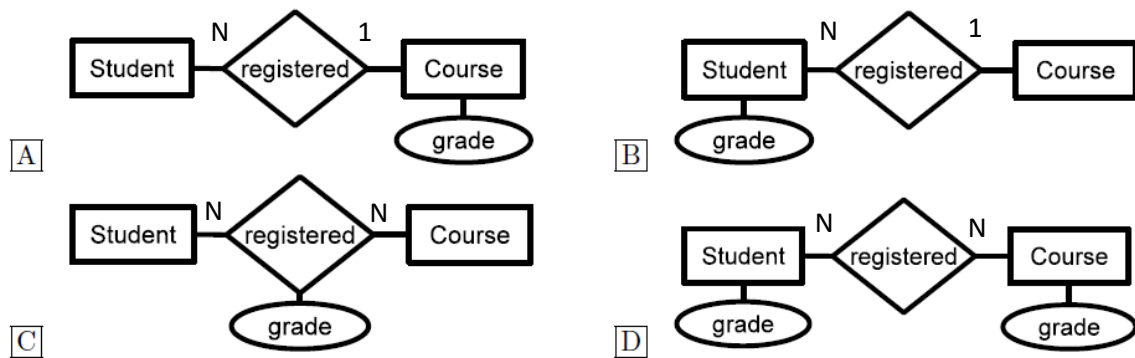
- ☐ A Each employee can work in many departments.
- ☐ B Many employees can work at the same department.
- ☐ C Each department has at least one employee.
- ☐ D Each employee has a unique combination of the first and last name.
- ☐ E A Department may have no employees.

Question 2 ♥ For the depicted ER model, select all statements that hold! (Select **all** correct choices)

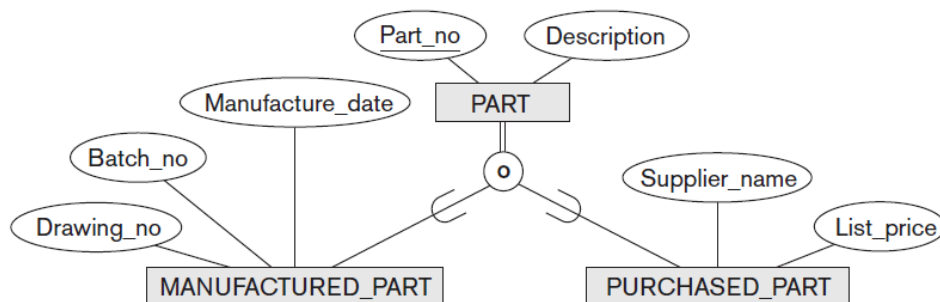


- ☐ A Citizens with IDs 12 and 13 co-own the car with registration number RID 23YYDD since 1/1/2020.
- ☐ B A citizen with ID 12 owns the car with registration number RID 23YYDD since 1/1/2020.
- ☐ C A Citizen may not own a car.
- ☐ D A vehicle may not belong to an owner.

Question 3 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)

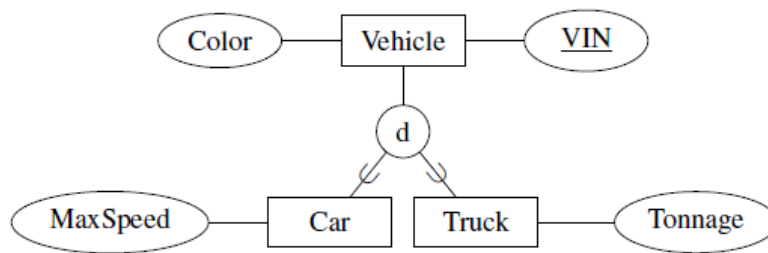


Question 4 ♥ Based on the EER model depicted below and the semantics of EER models, select all correct statements from the following.



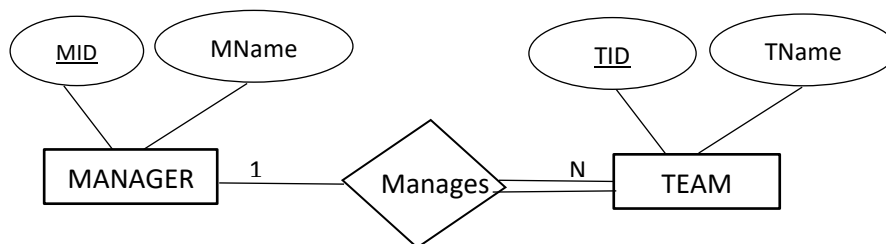
- A** An entity type PART may belong to any of the sub-classes (MANUFACTURED_PART or PURCHASED_PART).
- B** An entity type PART may be none of these sub-classes.
- C** An entity type PART may belong to more than one sub-classes at the same time.
- D** An entity type PART may belong to only one of the sub-classes at the same time.

Question 5 Consider we want to convert the following diagram to the relational model. Choose the MOST appropriate answer from the following.



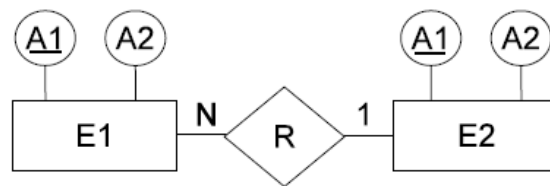
- A** Car(VIN, Color, MaxSpeed)
Truck(VIN, Color, Tonnage)
- B** Vehicle(VIN, Color)
Car(MaxSpeed)
Truck(Tonnage)
- C** Vehicle(VIN, Type, Color, MaxSpeed)
- D** Vehicle(VIN, Color)
Car(VIN, MaxSpeed)
Truck(VIN, Tonnage)

Question 6 Consider we want to convert the following diagram to the relational model. Select a valid solution.



- A** MANAGER(MID, MName)
TEAM(TID, TName, MID) with $MID^{FK} \rightarrow MANAGER(MID)$
- B** MANAGER(MID, MName, TID) with $TID^{FK} \rightarrow TEAM(TID)$
TEAM(TID, TName)
- C** MANAGERTEAM(MID, TID, MName, TName)
MANAGER(MID, TID) with $TID^{FK} \rightarrow MANAGERTEAM(TID)$ and $MID^{FK} \rightarrow MANAGERTEAM(MID)$
- D** MANAGER(MID, MName)
TEAM(TID, TName, MID) with $MID^{FK} \rightarrow MANAGER(MID)$
MANAGES(MID, TID)

Question 7 Which relational schema corresponds best 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)
- ☐ B E1(A1, A2), E2(A1, A2), R(E1, E2) (with R.E1 FK ref. E1.A1 and R.E2 FK ref. E2.A1)
- ☐ C E1(A1, A2), E2(A1, A2, E1) (with E2.E1 FK ref. E1.A1)
- ☐ D E1(E2, A1, A2), E2(A1, A2) (with E1.E2 FK ref. E2.A1)
- ☐ E E1(A1, A2, E2), E2(A1, A2) (with E1.E2 FK ref. E2.A1)
- ☐ F None of the other answers

Consider the following Student Data Record and answer questions 8-9. Where, a student can take one course and a course consists of several modules. 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	Introduction to Genetic Engineering	
GN 302	Advanced Genetic Engineering	
GN 303	Social Consequences of Genetic Eng	
.	.	
.	.	
.	.	
etc	etc	
Project Details		
Project Code: PR370/94		
Project Title: Building a Group of Friends		
Project Supervisor: Frank N. Stein		

Question 8 ♥ Which of the following full functional dependencies are true? (Select **all** correct choices)

- ☐ **A** Project Code \rightarrow {Project Title, Project Supervisor}
- ☐ **B** Module Code \rightarrow Module Name
- ☐ **C** Reg# \rightarrow Course
- ☐ **D** {Reg#, Project Code} \rightarrow {Project Title, Project Supervisor}
- ☐ **E** Reg# \rightarrow Project Code
- ☐ **F** {Reg#, Module Code} \rightarrow Module Name

Question 9 ♥ 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 Name)

Which of the following are true? (Select **all** correct choices)

- ☐ **A** STUDENT is in 3rd Normal Form (3NF)
- ☐ **B** STUDENT is in 2nd Normal Form (2NF)
- ☐ **C** STUDENT is in 1st Normal Form (1NF)
- ☐ **D** STUDENT_MOD is in 3NF
- ☐ **E** STUDENT_MOD is in 2NF
- ☐ **F** STUDENT_MOD is in 1NF

Consider the following database with the two tables STUDENT and SUPERVISOR. Where STUDENT.StudentID is a primary key to table STUDENT, SUPERVISOR.SupervisorID is a primary key to table SUPERVISOR, and STUDENT.SupervisorID is a foreign key to SUPERVISOR.SupervisorID. **Answer questions 10-17.**

STUDENT			
StudentID	StName	SupervisorID	Project Grade
1	Pericles	1	5
2	Alexander	1	5
3	Ptolemy	2	NULL
4	Euclid	3	4
5	Pythagoras	2	3
6	Aristotle	2	4

SUPERVISOR	
SupervisorID	SupName
1	Thor
2	Marcus
3	Magnus
4	Caesar

Question 10 Consider we want to get a list of the (i) IDs and (ii) names of the supervisors that actually supervise students. Which of the following statements will give this answer?

- A** Select SupervisorID, SupName
 From SUPERVISOR;
- B** Select Distinct SupervisorID, SupName
 From SUPERVISOR Left Join STUDENT on
 STUDENT.SupervisorID=SUPERVISOR.SupervisorID;
- C** Select Distinct SupervisorID, SupName
 From STUDENT, SUPERVISOR
 Where STUDENT.SupervisorID=SUPERVISOR.SupervisorID;
- D** Select Distinct SupervisorID, SupName
 From SUPERVISOR
 Where STUDENT.SupervisorID=SUPERVISOR.SupervisorID;

Question 11 Which of the following statements will return the amount of supervisors that are actually supervising students from table STUDENT?

- A** Select Distinct COUNT(*)
 From STUDENT, SUPERVISOR
 Where STUDENT.SupervisorID=SUPERVISOR.SupervisorID;
- B** Select COUNT(Distinct SUPERVISOR.SupervisorID)
 From STUDENT, SUPERVISOR
 Where STUDENT.SupervisorID=SUPERVISOR.SupervisorID;

- ☐ **C** Select COUNT(SUPERVISOR.SupervisorID)
 From SUPERVISOR Left Join STUDENT on
 STUDENT.SupervisorID=SUPERVISOR.SupervisorID;
- ☐ **D** Select COUNT(*)
 From SUPERVISOR;

Question 12 Which of the following statements will give the average of all project grades?

- ☐ **A** Select Avg(ProjectGrade)
 From STUDENT
 Group By ProjectGrade;
- ☐ **B** Select Avg(ProjectGrade)
 From STUDENT;
- ☐ **C** Select Avg(ProjectGrade)
 From STUDENT
 Group By StudentID;
- ☐ **D** None of the above.

Question 13 Which of the following statements will return (i) the average project grade of students per supervisor (ii) together with the supervisor's name?

- A** `Select SupName, Avg(ProjectGrade)`
 `From SUPERVISOR,STUDENT`
 `Where STUDENT.SupervisorID=SUPERVISOR.SupervisorID;`
- B** `Select SupName, Avg(ProjectGrade)`
 `From SUPERVISOR,STUDENT`
 `Where STUDENT.SupervisorID=SUPERVISOR.SupervisorID`
 `Group By SUPERVISOR.SupervisorID;`
- C** `Select SupName, Avg(ProjectGrade)`
 `From SUPERVISOR,STUDENT`
 `Where STUDENT.SupervisorID=SUPERVISOR.SupervisorID`
 `Group By STUDENT.StudentID;`
- D** `Select SupName, Avg(ProjectGrade)`
 `From SUPERVISOR Left Join STUDENT On`
 `STUDENT.SupervisorID=SUPERVISOR.SupervisorID`
 `Group By STUDENT.SupervisorID;`

Question 14 Which of the following statements will return the list with the IDs and names of supervisors who have at least one student with Project grade equal to 5?

- A** `Select SupervisorID, SupName`
 `From SUPERVISOR Join STUDENT On`
 `STUDENT.SupervisorID=SUPERVISOR.SupervisorID`
 `Where ProjectGrade=5;`
- B** `Select Distinct SupervisorID, SupName`
 `From SUPERVISOR,STUDENT`
 `Where ProjectGrade=5;`
- C** `Select Distinct SupervisorID, SupName`
 `From SUPERVISOR, STUDENT`
 `Where STUDENT.SupervisorID=SUPERVISOR.SupervisorID And`
 `ProjectGrade=5;`
- D** `Select SupervisorID, SupName`
 `From SUPERVISOR Left Join STUDENT On`
 `STUDENT.SupervisorID=SUPERVISOR.SupervisorID`
 `Where ProjectGrade=5;`

Question 15 Which of the following statements will return the following. An ordered list of (i) the names of all supervisors from SUPERVISOR (including also supervisors that supervise zero students) and (ii) the number of students they are supervising. The results should be ordered by the number of students each supervisor is supervising.

A `Select SupName, Count(*)
From SUPERVISOR,STUDENT
Where SUPERVISOR.SupervisorID = STUDENT.SupervisorID
Group By SUPERVISOR.SupervisorID
Order By SupName;`

B `Select SupName, Count(StudentID)
From SUPERVISOR Left Join STUDENT
On SUPERVISOR.SupervisorID = STUDENT.SupervisorID
Group By SUPERVISOR.SupervisorID
Order By Count(StudentID);`

C `Select SupName, Count(*)
From SUPERVISOR Right Join STUDENT
On SUPERVISOR.SupervisorID = STUDENT.SupervisorID
Group By SUPERVISOR.SupervisorID
Order By Count(StudentID);`

D `Select SupName, Count(StudentID)
From SUPERVISOR,STUDENT
Where SUPERVISOR.SupervisorID = STUDENT.SupervisorID
Group By SUPERVISOR.SupervisorID
Order By Count(StudentID);`

Question 16 Consider we need a list of all students who have finished their projects (i.e., students with grades not NULL) including (i) their name, (ii) their supervisor's name and (iii) their project grade. Which of the following statements will give this answer?

A `Select StName, SupName, ProjectGrade
From STUDENT,SUPERVISOR
Where STUDENT.SupervisorID=SUPERVISOR.SupervisorID;`

B `Select StName, SupName, ProjectGrade
From STUDENT Join SUPERVISOR on
STUDENT.SupervisorID=SUPERVISOR.SupervisorID;`

C Select StName, SupName, ProjectGrade
 From STUDENT Join SUPERVISOR on
 STUDENT.SupervisorID=SUPERVISOR.SupervisorID
 Where ProjectGrade Is Not Null;

D Select StName, SupName, ProjectGrade
 From STUDENT Left Join SUPERVISOR on
 STUDENT.SupervisorID=SUPERVISOR.SupervisorID;

E Select StName, SupName, ProjectGrade
 From STUDENT Right Join SUPERVISOR on
 STUDENT.SupervisorID=SUPERVISOR.SupervisorID;

Question 17 Which of the following statements will return the list with the names of supervisors who are not supervising any students.

A Select SupName
 From SUPERVISOR Left Join STUDENT on
 STUDENT.SupervisorID=SUPERVISOR.SupervisorID
 Where STUDENT.SupervisorID != SUPERVISOR.SupervisorID;

B Select SupName
 From SUPERVISOR ,STUDENT
 Where SUPERVISOR.SupervisorID = STUDENT.SupervisorID
 Group By STUDENT.SupervisorID;

C Select SupName
 From SUPERVISOR Join STUDENT on
 STUDENT.SupervisorID=SUPERVISOR.SupervisorID
 Where StudentID Is Null;

D Select SupName
 From SUPERVISOR
 Where SupervisorID Not In (Select SupervisorID From STUDENT);

Question 18 ♥ Consider the relation $R(\underline{A}, \underline{B}, C, D, E, F)$ with $\{A, B\}$ as a composite primary key and the following dependencies:

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

Which of the following options are true? (Select **all** correct choices)

- ☐ **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 2NF but not in 3NF
- ☐ **E** R is in 3NF but not in 2NF

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	Platon	George	Anna
2	Socrates	George	Chris
3	Pericles	George	Iliada
4	Alexander	John	Nek
5	Leonidas	John	Maria
6	Aristotle	Marina	Anna

- ☐ **A** It is certain that the functional dependency $C_1 \rightarrow C_2$ holds.
- ☐ **B** It is certain that the functional dependency $C_1 \rightarrow C_3$ holds.
- ☐ **C** It is certain that the functional dependency $C_2 \rightarrow C_3$ holds.
- ☐ **D** It is certain that the functional dependency $C_4 \rightarrow C_2$ does not hold.
- ☐ **E** It is certain that the functional dependency $C_3 \rightarrow C_4$ does not hold.

By considering the database below, answer **questions 20-23**. 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	<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 constraints of the following operation when applied on the above database.

Insert <'ProductX', 40, 'Bellaire', 4> into PROJECT

- ☐ **A** No constraint violations.
- ☐ **B** It violates the key constraint.
- ☐ **C** It violates the referential integrity.
- ☐ **D** It violates the entity integrity constraints.

Question 21 ♥ Choose the correct statements regarding the constraints of the following operation when applied on the above database. (Select **all** correct choices)

Insert < 'NULL', 4, '333445555', '1988-05-22' > into DEPARTMENT.

- ☐ **A** No constraint violations.
- ☐ **B** It violates the key constraint.
- ☐ **C** It violates the referential integrity.
- ☐ **D** It violates the entity integrity constraints.

Question 22 ♥ Choose the correct statements regarding the constraints of the following operation when applied on the above database. (Select **all** correct choices)

Set the EMPLOYEE.Ssn attribute to '123456789' of the EMPLOYEE tuple with EMPLOYEE.Ssn= '987654321'.

- ☐ **A** No constraint violations.
- ☐ **B** It violates the key constraint.
- ☐ **C** It violates the referential integrity.
- ☐ **D** It violates the entity integrity constraints.

Question 23 ♥ Choose the correct statements regarding the constraints of the following operation when applied on the above database. (Select **all** correct choices)

Set the **EMPLOYEE.Dno** attribute to '2' of the **EMPLOYEE** tuple with **EMPLOYEE.Ssn= '987654321'**.

- ☐ **A** No constraint violations.
- ☐ **B** It violates the key constraint.
- ☐ **C** It violates the referential integrity.
- ☐ **D** It violates the entity integrity constraints.

Question 24 Considering the following transactions and schedules, choose a correct statement.

<i>T1</i>	<i>T2</i>	<i>T1</i>	<i>T2</i>	<i>T1</i>	<i>T2</i>
<i>R(A)</i>			<i>R(A)</i>	<i>R(A)</i>	
<i>W(A)</i>			<i>W(A)</i>	<i>W(A)</i>	
	<i>R(A)</i>	<i>R(A)</i>			<i>R(A)</i>
	<i>W(A)</i>		<i>R(B)</i>		<i>W(A)</i>
<i>R(B)</i>			<i>W(B)</i>		<i>R(B)</i>
<i>W(B)</i>		<i>W(A)</i>			<i>W(B)</i>
	<i>R(B)</i>	<i>R(B)</i>		<i>R(B)</i>	
	<i>W(B)</i>	<i>W(B)</i>		<i>W(B)</i>	
	Commit		Commit		Commit
Commit		Commit		Commit	

Schedule A
Schedule B
Schedule C

- ☐ **A** Schedule A suffers from the lost update problem.
- ☐ **B** Schedule B suffers from the lost update problem.
- ☐ **C** Schedule C suffers from the lost update problem.
- ☐ **D** None of the schedules suffers from the lost update problem.