POSTAL BOOK PACKAGE 2025

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COMPUTER SCIENCE & IT

Objective Practice Sets

Databases

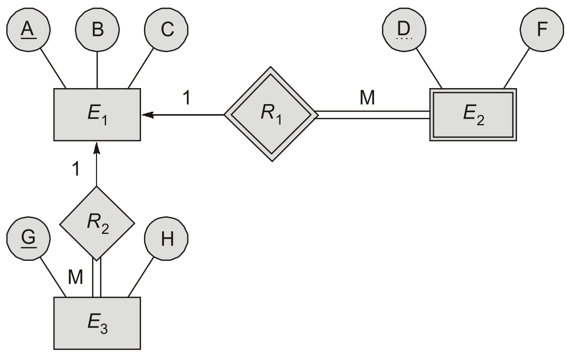
1 CHAPTER

Databases

The Relational Model

Multiple Choice Questions & NAT Questions

1. Consider the following ER-diagram:



The minimum number of tables needed to represent E_1, E_2 and E_3 are ________.

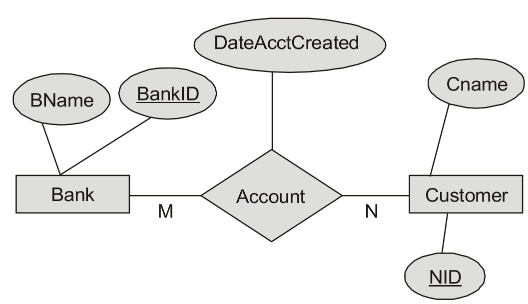
2. A weak entity ______.
   (a) is an entity with no attributes beside its key.
   (b) inherits part of its key from the 'parent' entities to which it is related.
   (c) is an entity with no key.
   (d) None of these

3. In the Relational Model, the number of attributes and number of tuples in a relation are termed as ______ and ______ respectively.
   (a) Cardinality, domain
   (b) Degree, cardinality
   (c) Domain, degree
   (d) Cardinality, degree

4. An ER model of a database consists of entity types A and B. These are connected by a relationship R which does not have its own attribute. Under which one of the following conditions, can the relational table for R be merged with that of A?
   (a) Relationship R is one-to-many and the participation of A in R is total.
   (b) Relationship R is one-to-many and the participation of A in R is partial.
   (c) Relationship R is many-to-one and the participation of A in R is total.
   (d) Relationship R is many-to-one and the participation of A in R is partial.

5. In an Entity-Relationship (ER) model, suppose R is a many-to-one relationship from entity set E1 to entity set E2. Assume that E1 and E2 participate totally in R and that the cardinality of E1 is greater than the cardinality of E2.
   Which one of the following is true about R?
   (a) Every entity in E1 is associated with exactly one entity in E2.
   (b) Some entity in E1 is associated with more than one entity in E2.
   (c) Every entity in E2 is associated with exactly one entity in E1.
   (d) Every entity in E2 is associated with at most one entity in E1.

6. Consider the following ERD diagram illustrating the relationship of customers and banks.

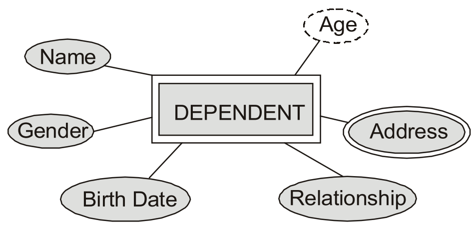


Select from among the following, candidates for relations, if the above ERD is mapped into a relational model.

1. Customer(<u>NID</u>, CName)
2. Account(<u>DateAcctCreated</u>, BName, CName)
3. Bank(<u>BankID</u>, NID, BName)
4. Bank(<u>BankID</u>, BName)
5. Account(<u>BankID, NID</u>, DateAccCreated)

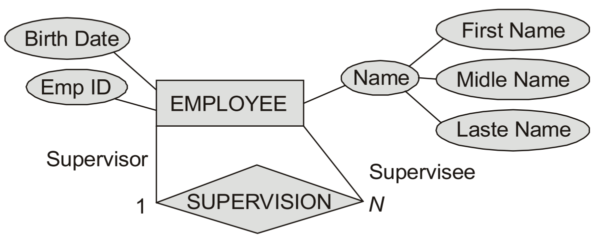
(a) 1, 2 and 4 (b) 1, 4 and 5
(c) 1, 3 and 5 (d) 1, 2 and 4

7. The following diagram represents the dependent entity from an Entity Relationship diagram.



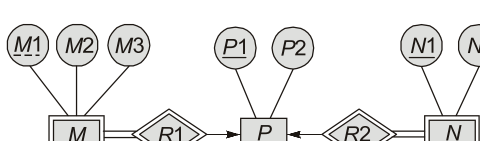
Select the characteristics which are not represented by the above diagram.
(a) Age is a derived attribute
(b) Gender is an atomic attribute
(c) Address is a multivalued attribute
(d) Name is a key attribute

8. Consider the following ERD diagram depicting the relationship of an employee and supervisor.



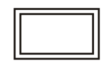
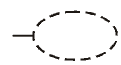
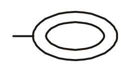
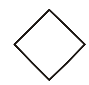
Which is the possible relations if the above ERD is mapped into a relational model?
(a) Employee (<u>EmpID</u>, BirthDate, Salary, <u>Name</u>(FirstName, MiddleName, LastName))
(b) Supervision (<u>EmpID</u>,BithDate, Salary, Name(FirstName, MiddleName, LastName), <u>EmpId</u>)
(c) Supervisor (<u>SupervisorID</u>, BirthDate, Salary, Name(FirstName, MiddleName, LastName), <u>EmpID</u>), {EmpID})
(d) Employee (EmpID, BirthDate, Salary, Name(FirstName, MiddleName, LastName), SupervisorID)

9. Consider the following ER diagram:



The minimum number of table needed to represent *M*, *N*, *P*, *R*1, *R*2 is
(a) 2 (b) 3
(c) 4 (d) 5

10. Match **List-I** with **List-II** and select the correct answer using the codes given below the lists:

List-I	List-II
A. 	1. Identifying relationship
B. 	2. Weak entity
C. 	3. Derived attribute
D. 	4. Multivalued attribute

Codes:

	A	B	C	D
(a)	1	3	4	2
(b)	2	4	3	1
(c)	2	3	4	1
(d)	1	4	3	2

11. Given the basic ER and relational models, which of the following is INCORRECT?
(a) An attribute of an entity can have more than one value
(b) An attribute of an entity can be composite
(c) In a row of a relational table, an attribute can have more than one value
(d) In a row of a relational table, an attribute can have exactly one value or a NULL value

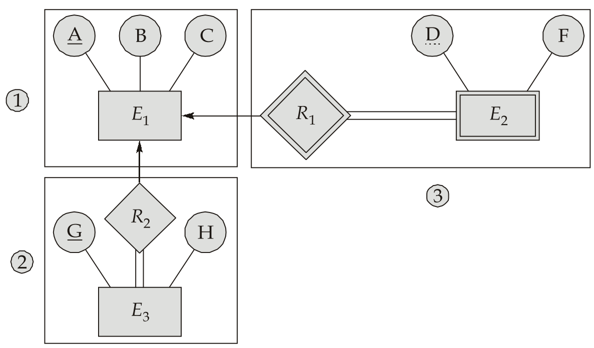
12. Consider an Entity-Relationship (ER) model in which entity sets E_1 and E_2 are connected by an $m : n$ relationship R_{12}. E_1 and E_3 are connected by a 1 : n (1 on the side of E_1 and n on the side of E_3) relationship R_{13}.
E_1 has two single-valued attributes a_{11} and a_{12} of which a_{11} is the key attribute. E_2 has two single-valued attributes a_{21} and a_{22} of which a_{21} is the key attribute. E_3 has two single-valued attributes a_{31} and a_{32} of which a_{31} is the key attribute. The relationships do not have any attributes.

Answers The Relational Model

1. (3)	2. (c)	3. (b)	4. (c)	5. (a)	6. (b)	7. (d)	8. (d)	9. (a)
10. (c)	11. (c)	12. (4)	13. (b)	14. (50)	15. (5)	16. (b)	17. (a)	18. (3)
19. (b, d)	20. (a, b, d)	21. (a, c, d)						

Explanations The Relational Model

1. (3)



R_1(<u>A</u>, B, C, G), R_2(<u>G</u>, H), R_3(<u>D</u>, F, A)
Only 3 tables are required.

2. (c)

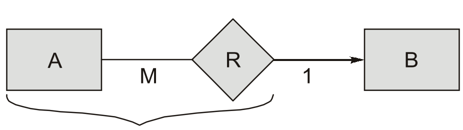
A weak entity is an entity which depends on some other entity and having no key.

3. (b)

Number of attributes are called as degree while number of tuples are called as cardinality.

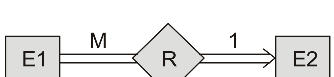
4. (c)

Entity sets A, B
Relationship set R
Relation R merges with that of A.

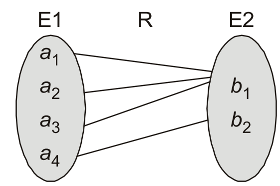


- Many to one relationship set can merge towards entity set 'A'.
- Participation towards A side can be total/ partial.

5. (a)

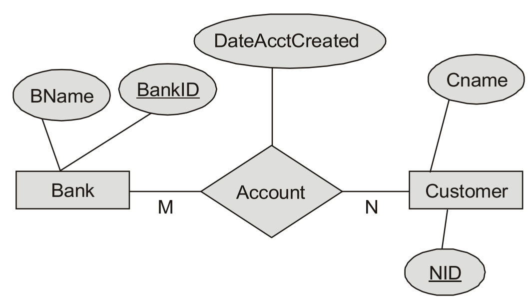


E1 entries > E2 entities



Every entity in E1 is associated with exactly one entity in E2.

6. (b)



Above ER diagram showing many to many relationship. Thus, a separate table is needed for relationship. Hence, 3 tables required i.e.,

1. Bank (<u>BankID</u>, BName)
2. Customer (<u>NID</u>, Cname)
3. Account (<u>BankID, NID</u>, DateAccCreated)

7. (d)

Dependent is a weak entity.
Age is a derived attribute since, inside dotted oval.
Gender is an atomic since under solid oval.
Address is multivalued attribute because it is double oval.
Name is not a key attribute since no underline.

8. (d)

The given ERD shows the self recursively relationship among Employees.
1 is supervisor 2 is supervisee.

2 CHAPTER Database Design and Normalization

Multiple Choice Questions & NAT Questions

1. Given FD = $\{AB \to C, CD \to E, E \to FG, G \to H\}$. Find which of the following can be a possible deduction from given functional dependencies.
   (a) $DFG \to E$ (b) $ACD \to B$
   (c) $ABD \to E$ (d) None of these

2. Consider a relation 'R', all of its candidate keys are singletons. If R is in 3NF then R is ______.
   (a) BCNF
   (b) Not BCNF
   (c) May not be BCNF
   (d) Information is not sufficient

3. Consider R = ABCDEFGH and the following FD's:
   $H \to GD$
   $E \to D$
   $HD \to CE$
   $BD \to A$
   Identify the minimal cover of the given FD's?
   (a) $\{H \to G, E \to D, H \to C, HD \to E, BD \to A\}$
   (b) $\{H \to G, H \to D, E \to D, H \to C, BD \to A\}$
   (c) $\{H \to G, E \to D, H \to C, HD \to C, BD \to A\}$
   (d) $\{H \to G, E \to D, H \to C, H \to E, BD \to A\}$

4. Consider a relation $R(A\ B\ C\ D\ E)$ with sets of FD's $F\{A \to B, BC \to E, ED \to A\}$ Given R is in which highest normal forms?
   (a) 1 NF (b) 2 NF
   (c) 3 NF (d) BCNF

5. Let R be the relational schema with FDs F, is decomposed into R_1 and R_2 is loss less join decomposition only if
   (a) (i) $R_1 \cup R_2 \subset R$
   (ii) $R_1 \cap R_2 \neq \phi$
   (iii) $R_1 \cap R_2$ gives candidate key that should be primary key in either R_1 or R_2
   (b) (i) $R_1 \cup R_2 \equiv R$
   (ii) $R_1 \cap R_2 \neq \phi$
   (iii) $R_1 \cap R_2$ gives candidate key that should be primary key in either R_1 or R_2
   (c) (i) $R_1 \cup R_2 \equiv R$
   (ii) $R_1 \cap R_2 \neq \phi$
   (iii) $R_1 \cap R_2$ gives candidate key that should not be primary key in either R_1 or R_2
   (d) (i) $R_1 \cup R_2 \not\equiv R$
   (ii) $R_1 \cap R_2 \neq \phi$
   (iii) $R_1 \cap R_2$ gives candidate key that should not be primary key in either R_1 or R_2

6. Consider the relation schema $S = \{A, B, C, D\}$ and the following functional dependencies on S.
   $A \to BCD$
   $B \to C$
   $CD \to A$
   Which of the following is true?
   (a) S is in 3 NF and also in BCNF
   (b) S is in 3 NF but not in BCNF
   (c) S is in 2 NF but not in 3 NF
   (d) S is in BCNF but not in 3 NF

7. A relation R with two attribute is always in
   (a) 1 NF (b) 2 NF
   (c) 3 NF (d) BCNF

8. Consider the universal relation $R = \{A, B, C, D, E, F, G, H, I, J\}$ and the set of FD, $F = \{AB \to C, A \to DE, B \to F, F \to GH, D \to IJ\}$. R is decomposed into
   $R_1 = \{A, B, C, D, E\}$
   $R_2 = \{B, F, G, H\}$
   $R_3 = \{D, I, J\}$
   Then the decomposition of R is
   (a) Lossless join and dependency preservation
   (b) Lossy but dependency preservation
   (c) Lossless join but not dependency preservation
   (d) Lossy and loss of dependency

9. Consider the following relation:
Vehicle (vehicle No, sold_date, salesmanNo, commission%, discount_amt)
Assume that a vehicle may be sold by multiple salesman and vehicle {vehicle No, salesmanNo} is Primary key. Additional dependencies are Sold_date $\rightarrow$ discount_amt and salesmanNo $\rightarrow$ commission%.
Given relation is in which normal form?
(a) 1 NF (b) 2 NF
(c) 3 NF (d) None of these

10. Given the relational schema $R(A, B, C, D, E)$ with the following functional dependencies.
$A \rightarrow B$, $BD \rightarrow E$, $C \rightarrow AD$, $E \rightarrow C$
Find which of the following is not a candidate key?
(a) E (b) C
(c) BD (d) A

11. Find the number of FD's in the minimal cover of following FD set FD = $\{A \rightarrow B, CD \rightarrow A, CB \rightarrow D, CE \rightarrow D, AE \rightarrow F, AC \rightarrow D\}$.
(a) 2 (b) 3
(c) 4 (d) 5

12. Find the number of possibilities to choose a primary key of the relation $R(A, B, C, D, E)$.
(a) 5 (b) 25
(c) 31 (d) 120

13. Let R is a relation schema, $R(A, B, C, D)$ and $F = \{A \rightarrow B, B \rightarrow C, C \rightarrow A\}$ is the set of functional dependency. How many candidate keys are there?
(a) 1 (b) 2
(c) 3 (d) None of these

14. Suppose we have a relation $R(A, B, C)$ with multivalued dependency $\{A \rightarrow\rightarrow B\}$. If we know that tuples (a, b1, c1), (a, b2, c2,), (a, b2, c3,), (a, b3, c3,) are in R what other tuples do we know must also be in R
(a) (a, b1, c2), (a, b1, c3), (a, b2, c1)
(b) (a, b1, c2), (a, b2, c1), (a, b3, c1), (a, b3, c1), (a, b3, c2)
(c) (a, b1, c2), (a, b1, c3), (a, b2, c1), (a, b3, c1), (a, b3, c2)
(d) None of the above

15. Consider the relation given below and find the maximum normal form applicable to them
1. $R(A, B)$ with productions $\{A \rightarrow B\}$
2. $R(A, B)$ with productions $\{B \rightarrow A\}$
3. $R(A, B)$ with productions $\{A \rightarrow B, B \rightarrow A\}$
4. $R(A, B, C)$ with productions $\{A \rightarrow B, B \rightarrow A, AB \rightarrow C\}$
(a) 1, 2 and 3 are in 3NF and 4 is in BCNF
(b) 1 and 2 are in BCNF and 3 and 4 are in 3NF
(c) All are in 3NF
(d) All are in BCNF

16. Consider the relation $R(A, B, C, D, E)$ and the set
$F = \{AB \rightarrow CE, E \rightarrow AB, C \rightarrow D\}$
What is the highest normal form of this relation?
(a) 1NF (b) 2NF
(c) 3NF (d) BCNF

17. Given the relation $R(X, Y, W, Z, P, Q)$ and the set
$F = \{XY \rightarrow W, XW \rightarrow P, PQ \rightarrow Z, XY \rightarrow Q\}$
Consider the decomposition $R_1(Z, P, Q)$ and $R_2(X, Y, W, P, Q)$. This decomposition is
(a) Lossless decomposition
(b) Lossy decomposition
(c) Either lossless or lossy
(d) Neither lossless or lossy

18. Consider the relation SCHEDULE shown below. What is the highest normal form of this relation?
SCHEDULE (Student_ID, Class_No, Student_Name, Student_Major, Class_Time, Building _Room, Instructor).
Assume the following functional dependencies {Student_ID $\rightarrow$ Student_Name, Student_ID $\rightarrow$ Student_Major, Class_No $\rightarrow$ Class_time, Class_No $\rightarrow$ Building Room, Class_No$\rightarrow$ Instructor}
(a) 1NF (b) 2NF
(c) 3NF (d) BCNF

19. A relation R is defined as R(S#, STATUS, CITY, SNAME) where S# is the primary key. If R is decomposed into two relations R_1 and R_2, which of the following is a loss less decomposition?
(a) R_1 (S#, STATUS), R_2(S#, CITY, SNAME)
(b) R_1(S#, STATUS), R_2(STATUS, CITY, SNAME)
(c) R_1(S#, STATUS, CITY), R_2 (CITY, SNAME)
(d) R_1(S#, STATUS, SNAME), R_2(CITY, STATUS)

20. Consider the relation $R(S, T, U, V)$ and the set $F = \{S \rightarrow T, T \rightarrow U, U \rightarrow V$ and $V \rightarrow S\}$. Let R is decomposed into R_1 and R_2 such that $R_1 \cap R_2 = \phi$, the decomposition is
(a) Lossless decomposition
(b) Lossy decomposition
(c) Dependency preservation
(d) Cannot say

Answers Database Design and Normalization

1. (c)	2. (a)	3. (d)	4. (c)	5. (b)	6. (b)	7. (d)	8. (a)	9. (d)
10. (a)	11. (d)	12. (c)	13. (c)	14. (c)	15. (d)	16. (b)	17. (a)	18. (a)
19. (a)	20. (b)	21. (a)	22. (c)	23. (b)	24. (a)	25. (c)	26. (c)	27. (b)
28. (a)	29. (d)	30. (b)	31. (d)	32. (c)	33. (a)	34. (b)	35. (b)	36. (c)
37. (c)	38. (c)	39. (c)	40. (c)	41. (d)	42. (c)	43. (b)	44. (c)	45. (b)
46. (d)	47. (d)	48. (d)	49. (c)	50. (c)	51. (a)	52. (c)	53. (0)	54. (c)
55. (b)	56. (a)	57. (a)	58. (a)	59. (d)	60. (d)	61. (100)	62. (a)	63. (b)
64. (a)	65. (b)	66. (a)	67. (7)	68. (b)	69. (2)	70. (26)	71. (d)	72. (4)
73. (d)	74. (28)	75. (4)	76. (1)	77. (2)	78. (3)	79. (a, b, c)	80. (a, b, c, d)	
81. (b, c)	82. (a, b, d)	83. (a, b, c)	84. (a, b, d)	85. (a, b)				

Explanations Database Design and Normalization

1. (c)

$AB \to C$

Augment 'D'

$ABD \to CD$

and we have $CD \to E$.

$\therefore$ Transitively : $ABD \to E$ is a possible deduction.

OR

$(ABD)^+ = ABCDEFGH$

$\therefore$ $ABD \to E$ is possible

2. (a)

Given R is in 3NF.

Either FD LHS is key or RHS is prime attributes.

If LHS FD is a key then it is BCNF

If RHS FD is prime attribute then it must be key, because all candidate keys are singleton. So it is also in BCNF.

$\therefore$ R is also in BCNF

3. (d)

Given FDs:

$H \to GD$

$E \to D$

$HD \to CE$

$BD \to A$

(1) Right reduced FDs:

$H \to G$

$H \to D$

$E \to D$

$HD \to C$

$HD \to E$

$BD \to A$

(2) Left reduced FDs:

$H \to G$

$H \to D$

$E \to D$

$H \to C$

$H \to E$

$BD \to A$

(3) Minimal cover:

$H \to G$

$E \to D$

$H \to C$

$H \to E$

$BD \to A$

4. (c)

$$F = \{A \to B, BC \to E, ED \to A\}$$

$A^+ = A, B,$

$(BC)^+ = B, C, E$

$(ED)^+ = E, D, A, B$

So candidate keys may be $\{EDC, BCD, ACD\}$ and prime attributes are $\{A, B, C, D, E\}$

BCNF: If $x \to y$ then x should be candidate key then the relation will be in BCNF. In the given FDs set $\{A \to B, BC \to E, ED \to A\}$, x may be A or BC or ED which are not candidate key so given relation is not in BCNF.

3NF: If $x \to y$ then (i) x should be candidate key, or (ii) y should be prime attribute in our given relation y may be B, E, A, which are prime attributes. So given relation is in 3 NF.

6. (b)

$$F = \{A \to BCD, B \to C, CD \to A\}$$
$$A^+ = A\,B\,C\,D$$
$$CD^+ = A\,B\,C\,D$$

So candidate keys are $\{A, CD\}$

Prime attributes are $\{A, C, D\}$

Check for BCNF :

$A \to BCD$ ✓ ($\because$ A is candidate key)

$B \to C$ X ($\because$ B is not candidate key)

$CD \to A$ ✓ (CD is candidate key)

Check for 3NF :

$A \to BCD$ ✓ ($\because$ A is candidate key)

$B \to C$ ✓ ($\because$ C is prime attribute)

$CD \to A$ ✓ ($\because$ CD is candidate key)

7. (d)

Let the relation is $R(A, B)$

If A is key then $A \to B$ which is in BCNF

If B is key then $B \to A$ which is also in BCNF

If AB is key then $AB \to AB$ which is in BCNF

So $R(A, B)$ will always in BCNF

8. (a)

$F = \{AB \to C, A \to DE, B \to F, F \to GH, D \to IJ\}$

$(AB)^+ = \{A\,B\,C\,D\,E\,F\,G\,H\,I\,J\}$

So AB is candidate key

R (A B C D E F G H I J)

R_1(A B C D E) R_2(B F G G) R_3(D I J)

⋈

$$\left\{\begin{array}{l}\text{Common attribute between } R_1 \text{ and } R_2 \text{ is } B \\ \because B^+ = B, F, G, H \\ \text{so } B \text{ is c.key in } R_2\end{array}\right\}$$

R_{12} (A B C D E F G H) $R_3(D, I, J)$

⋈

$$\left\{\begin{array}{l}\text{Common attribute between } R_{12} \text{ and } R_3 \text{ is } D \\ D. \text{ and } D^+ = D, I, J \\ \text{so } D \text{ is c. key in } R_3\end{array}\right\}$$

So $R_{123}(A\ B\ C\ D\ E\ F\ G\ H\ I\ J)$

The this decomposition is loss less decomposition.

Check for dependency preservation

R (A B C D E F G H I J)

R_1 (A, B, C, D, E) | $A^+ = A, D, E$
$F_1 = \{AB \to CDE\}$ | $B^+ = B$
$\{A \to DE\}$ | $(AB)^+ = A, B, C, D, E$

R_2 (B, F, G, H) | $B^+ = B, F, G, H$
$F_2 = \{B \to FGH\}$ | $F^+ = F, G, H$
$\{F \to GH\}$

R_3 (D, I, G) | $D^+ = D, I, G$
$F_2 = \{D \to IJ\}$

$$F_1 \cup F_2 \cup F_3 = \left\{\begin{array}{lll} AB \to CDE, & B \to FGH, & D \to IJ \\ A \to DE, & F \to GH & \end{array}\right\}$$
$$\equiv F$$

So $F_1 \cup F_2 \cup F_3$ is equivalent to F.

So dependency is preserved.

9. (d)

In the given relation salesman No. has multiple attribute so it is not in 1NF.

10. (a)

$$(E)^+ = ECADB = ABCDE$$
$$(C)^+ = ABCDE$$
$$(BD)^+ = ABCDE$$

$(A)^+$ can not determine all attributes.

$\therefore$ A is not a candidate key.

11. (d)

$AC \to D$ can be eliminated, it can be derived from $A \to B$ and $CB \to D$ using augmentation and transitive rule.

$$A \to B \Rightarrow AC \to BC$$
$$\Rightarrow AC \to D$$

and remaining FDs are not possible to eliminate.

$\therefore$ 5 FDs are there in the minimal cover.

12. (c)

Number of possible primary keys are :

$2^5 - 1 = 31$ (with zero attributes not possible)

13. (c)

The candidate keys are AD, BD and CD.

14. (c)

If the MD $A \to\to B$ holds, then the MD $A \to\to C$ also holds. Notice that all the A values are the same.

Relational Algebra

Multiple Choice Questions & NAT Questions

1 Which of the following relational algebraic operation is not a commutative operation?
(a) Union (b) Intersection
(c) Selection (d) Projection

2 Consider a banking database with the following table with three attributes loans (br_name, loan_no, amount). Find the appropriate query for the given statements below.
"Find the loan number for each loan of an amount greater than 20000"
(a) $\{t \mid t \in \text{loans} \wedge t[\text{amount}] > 20000\}$ where 't' is a tuple
(b) $\{t \mid \exists\ s \in \text{loans}\ (t[\text{loan\_no}] = S[\text{loan\_no}] \wedge [\text{amount}] > 20000\}$
(c) $\{t \mid \forall\ s \in \text{loans}\ (t[\text{loan\_no}] = S[\text{loan\_no}] \wedge [\text{amount}] > 20000\}$
(d) None of the above

3 Which of the following is wrong?
(a) $\pi_{L_1 \cup L_2}(E_1 \bowtie_\theta E_2) = (\pi_{L_1}(E_1)) \bowtie_\theta (\pi_{L_1}(E_2))$
(b) $\sigma_P(E_1 - E_2) = \sigma_P(E_1) - E_2$
(c) $\sigma_{\theta_1 \wedge \theta_2}(E) = \sigma_{\theta_1}(\sigma_{\theta_2}(E))$
(d) $E_1 \bowtie_\theta E_2 = E_2 \bowtie_{\theta_1} E_1$

4 Information about a collection of students is given by the relation studInfo (<u>studId</u>, name, sex). The relation enroll (<u>studId, CourseId</u>) gives which student has enrolled for (or taken) what course(s). Assume that every course is taken by at least one male and at least one female student. What does the following relational algebra expression represent?
$\pi_{\text{courseId}}((\pi_{\text{studId}}(\sigma_{\text{sex = "female"}}(\text{studInfo})) \times \pi_{\text{courseId}}(\text{enroll})) - \text{enroll})$
(a) Courses in which all the female students are enrolled
(b) Courses in which a proper subset of female students are enrolled
(c) Courses in which only male students are enrolled
(d) None of the above

5 Select the relational expression which could possibly return the following result.

a	*c*
1	2
2	3

(a) $\Pi_{a, c}(\sigma_{a = c} R)$ (b) $\Pi_{a < c}(\Pi_{a, c} R)$
(c) $\Pi_{a < 2} R$ (d) $\sigma_{a < c}(\Pi_{a, c} R)$

6 Consider the following declaration:
$r_1 = \pi_{\text{branch\_name}}(\sigma_{\text{branch\_city = " Dadar"}}(\text{branch}))$
$r_2 = \pi_{\text{cust\_name, branch\_name}}(\text{depositor} \bowtie \text{account})$
Then to find the customers who appears in r_2, with every branch name in r_1, the query is:
(a) $\pi_{\text{branch\_name}}(\sigma_{\text{branch\_city = " Dadar"}}(\text{branch})) \cap \pi_{\text{cust\_name, branch\_name}}(\text{depositor} \bowtie \text{account})$
(b) $\pi_{\text{cust\_name, branch\_name}}(\text{depositor} \bowtie \text{account}) \cap \pi_{\text{branch\_name}}(\sigma_{\text{branch\_city = " Dadar"}}(\text{branch}))$
(c) $\pi_{\text{branch\_name}}(\sigma_{\text{branch\_city = " Dadar"}}(\text{branch})) \div \pi_{\text{cust\_name, branch\_name}}(\text{depositor} \bowtie \text{account})$
(d) $\pi_{\text{cust\_name, branch\_name}}(\text{depositor} \bowtie \text{account}) \div \pi_{\text{branch\_name}}(\sigma_{\text{branch\_city = " Dadar"}}(\text{branch}))$

7 Consider the following relation schemas:
b-Schema = (*b*-name, *b*-city, assets)
a-Schema = (*a*-num, *b*-name, bal)
d-Schema = (*c*-name, *a*-number)
Let branch, account depositor be respectively instance of the above schemas. Assume that account and depositor relations are much bigger than the branch relation.
Consider the following query:
$\Pi_{\text{c-name}}(\sigma_{\text{b-city= "Agra"} \wedge \text{bal} < 0}(\text{branch} \bowtie (\text{account} \bowtie \text{depositor})))$
Which one of the following queries is the most efficient version of the above query?
(a) $\Pi_{\text{c-name}}(\sigma_{\text{bal} < 0}(\sigma_{b\text{-city = "Agra"}}\ \text{branch} \bowtie \text{account} \bowtie \text{depositor})$

(b) $\Pi_{c\text{-name}}(\sigma_{b\text{-city} = \text{"Agra"}}\text{branch} \bowtie (\sigma_{\text{bal} < 0}\text{account} \bowtie \text{depositor}))$

(c) $\Pi_{c\text{-name}}(\sigma_{b\text{-city} = \text{"Agra"}}\text{branch} \bowtie \sigma_{b\text{-city} = \text{"Agra"} \Delta \text{bal} < 0}\text{account} \bowtie \text{depositor})$

(d) $\Pi_{c\text{-name}}(\sigma_{b\text{-city} = \text{"Agra"}}\text{branch} \bowtie (\sigma_{b\text{-city} = \text{"Agra"} \Delta \text{bal} < 0}\text{account} \bowtie \text{depositor}))$

8 Which of the following relational query language have the same expressive power?

1. Relational Algebra.
2. Tuple relational calculus restricted to safe expression.
3. Domain relational calculus restricted to safe expression.

(a) 2 and 3 only (b) 1 and 2 only
(c) 1 and 3 only (d) 1, 2 and 3

9 If P and Q are predicates and e is the relational algebra expression, then which of the following equivalence is valid?

(a) $\sigma_P(\sigma_Q(e)) = \sigma_Q(\sigma_P(e))$
(b) $\sigma_P(\sigma_Q(e)) = \sigma_{P \wedge Q}(e)$
(c) $\sigma_Q(\sigma_P(e)) = \sigma_{P \wedge Q}(e)$
(d) All of the above

10 Which of the following sets of operations represent a complete set of relational algebra operations?

(a) { ó, ð, ∪, –, X } (b) { ó, ð, ∪, ÷ , X }
(c) { ó, ð, ∩, –, X } (d) {ð , ∪, ó, –, ÷ }

11 Consider the given schema:
Client (customer-name, banker-name)
Customer (customer-name, street, customer-city)

which of the following queries finds the clients of banker Atul and the city they live in?

(a) $\pi_{\text{Client.customer-name,customer-city}}(\sigma_{\text{Client.customer-name = Customer.cutomer-name}}(\sigma_{\text{Banker-name = "Atul"}}(\text{Client} \times \text{Customer})))$

(b) $\pi_{\text{customer-name,customer-city}}(\sigma_{\text{banker-name = "Atul"}}(\text{Client} \times \text{Customer}))$

(c) $\pi_{\text{Client.customer-name, customer-city}}(\sigma_{\text{banker-name = "Atul"}}(\sigma_{\text{Client.customer-name = customer.customer-name}}(\text{Client} \times \text{Customer}))$

(d) $\pi_{\text{customer-name, customer-city}}(\sigma_{\text{banker-name = "Atul"}}(\text{Client} \times \text{Customer}))$

12 Translate the following tuple relational calculus expression into English language.
$\{ t \mid \exists S \in \text{student} (t[S.\text{name}]) = S[S.\text{name}] \wedge \exists u \in \text{course} (u[S.\text{no}] = S[S.\text{no}] \wedge u[\text{course name}] = \text{"}CS\text{"}]]\}$

(a) Select all tuples of student name
(b) Select all tuples of student name studying "CS" course
(c) Set of all tuples of students name with same course number and student number who are studying "CS" course
(d) None of these

13 The relational algebra expression equivalent to the following tuple calculate expression:
$\{t \mid t \in r \wedge (t[A] = 10 \wedge t[B] = 20)\}$ is

(a) $\sigma_{(A = 10 \vee B = 20)}(r)$
(b) $\sigma_{(A = 10)}(r) \cup \sigma_{(B = 20)}(r)$
(c) $\sigma_{(A = 10)}(r) \cap \sigma_{(B = 20)}(r)$
(d) $\sigma_{(A = 10)} - \sigma_{(B = 20)}(r)$

14 Given the relations
Employee (name, salary, deptno) and
Department (deptno, deptname, address)

which of the following queries cannot be expressed using the basic relational algebra operation (σ, π, $\times$, $\bowtie$, $\cup$, $\cap$, $-$)?

(a) Department address of every employee
(b) Employees whose name is the same as their department name
(c) The sum of all employees salaries
(d) All the employees of a given department

15 Consider the database having the following relations:

Products (pid, pname, city-quantity, price)
Customers (cid, cname, city, discount)
Agents(aid, aname, city, percent)

Orders(orderno, month, cid, aid, pid, qty, dollors)
Which of the following returns ''the customers who place order only through agent a_3''?

(a) $\pi_{\text{name}}(\text{Customers} \bowtie (\pi_{\text{cid}}(\text{Customers})\text{-}\pi_{\text{aid}}(s_{\text{cid}} = a_3(\text{Orders})))$
(b) $\pi_{\text{cname}}(\text{Customers} \bowtie (\pi_{\text{cid}}(\text{Customers})\text{-}\pi_{\text{cid}}(s_{\text{aid}} = a_3(\text{Orders}))))$
(c) $\pi_{\text{cid}}(\text{Orders})\text{-}\pi_{\text{cid}}(\sigma_{\text{aid} \neq a3}(\text{Orders}))$
(d) None of the above

Answers Relational Algebra

1. (d)	2. (b)	3. (d)	4. (d)	5. (d)	6. (d)	7. (b)	8. (d)	9. (d)
10. (a)	11. (a)	12. (b)	13. (c)	14. (c)	15. (c)	16. (b)	17. (b)	18. (c)
19. (a)	20. (d)	21. (d)	22. (d)	23. (c)	24. (a)	25. (c)	26. (4000)	27. (a)
28. (c)	29. (4)	30. (240)	31. (c)	32. (c)	33. (6)	34. (100)	35. (3)	36. (b)
37. (d)	38. (a)	39. (2)	40. (b)	41. (6)	42. (c)	43. (a)	44. (a)	45. (c)
46. (c)	47. (d)	48. (c)	49. (a)	50. (a, b, c)	51. (a, b, d)			

Explanations Relational Algebra

2. (b)

Loans (br_name, loan_no, amount)

For the query "find the loan number for each loan of an amount greater than 2000".

We have to check for each loan to find a loan number which is greater than 20,000.

Clearly, (b) $[t \mid \exists\ s \in$ loans $(t$ [loan_no.] = S[loan_no.] $\wedge$ [amount] > 20000}

3. (d)

$E_1 \bowtie_\theta E_2 = E_2 \bowtie_\theta E_1$ is not equivalent because θ join is not commutative.

Hence the entries in $E_1 \bowtie_\theta E_2$ and $E_2 \bowtie_\theta E_1$ may not be same.

4. (d)

Stud Info(<u>stud Id</u>, name, sex)

Enrol (<u>Stud Id, course Id</u>)

The relational algebra expression

$\pi_{\text{course Id}}((\pi_{\text{stud Id}}(\sigma_{\text{sex = "female"}}(\text{stud Info})) \times \pi_{\text{course Id}}(\text{enrol}) - \text{enrol})$

represents courses in which a proper subset of female students are enrolled.

Hence, option (d) is correct.

5. (d)

a	c
1	2
2	3

As we can see clearly both entries of $(a < c)$. Also for selecting the entries we have to project on R. Hence (d) $\sigma_{a < c}(\Pi_{a, c} R)$ is the correct option.

7. (b)

Branch: (b_name, b_city, assets)

Account: (a_num, b_name, bal)

depositor: (c_name, a_number)

$\pi_{c\_name}(\sigma_{b\_city = \text{'Agra'} \wedge \text{bal} < 0}(\text{branch} \bowtie (\text{account} \bowtie \text{depositor})))$

(a) $\pi_{c\_name}(\sigma_{\text{bal}<0}(\sigma_{b\_city\ =\ \text{'Agra'}}$ **branch** $\bowtie$ **account** $\bowtie$ **depositor**))

This join condition will increase the number of results / tuples and at the end, condition is applied which is inefficient.

(b) $\pi_{c\_name}(\sigma_{b\_city = \text{'Agra'}}\ \text{branch} \bowtie (\sigma_{\text{bal}<0}\ \text{account} \bowtie \text{depositor}))$

$\sigma_{b\_city = \text{'Agra'}}$ branch gives the tuples with b_city = 'Agra' ...(2)

$\sigma_{\text{bal}<0}$ account $\bowtie$ depositor finds those acc_num balance less than 0 ...(1)

The join of (1) and (2) gives less number of tuples comparatively option (c) and (d) will also give more number of tuples because of the join conditions and the join operations of tables.

So, option (b) is correct.

9. (d)

Since selection operation is commutative thus all of the above are valid conditions basically they are evaluating $P \wedge Q$.

10. (a)

$\{\sigma, \pi, \cup, -, X\}$ these contribute a complete set of relational algebra operation.

11. (a)

$\sigma_{\text{banker\_name= 'Atul'}}$ (client $\times$ Customer) ...(1)

It finds the combinations of all clients and customer whose banker name is Atul.

$\sigma_{\text{client.customer\_name = Customer.customer\_name}}((1))$

It finds those tuples where both tables have same customer name with banker_name as Atul and finally, the π conditions retrieves their names and customer-city of clients of banker 'Atul'.

12. (b)

The tuple relational calculus evaluates all those students having course_name as '*CS*'.

13. (c)

Option (c) is valid as it calculates the **intersection** of different tables having $A = 10$ and $B = 20$ separately.

14. (c)

The sum operation can't be performed with the basic algebra operation.

15. (c)

$\pi_{cid}(\text{orders}) - \pi_{cid}(\sigma_{aid \neq a3})(\text{orders}))$

The above query evaluates those customers who ordered through agent a_3.

16. (b)

Query gives the roll no. and name of those students who are female (sex=f) and who are in maths department (d.name= 'math').

17. (b)

As *C* is referring to R_2 and *D* is primary key of R_2, $\pi_C(r_1) - \pi_D(r_2)$ will give empty relation or empty table as number of values in *C* column of table r_1 will always refer to of respective values in *D* column of r_2.

18. (c)

From the options, option (c) is giving the best explanation of the query that it gives names of all students who have taken at least 1 course under their advisor.

19. (a)

The query gives all those names who have issued/ borrow a book from 'Narosa' but not 'Allied'.

20. (d)

It gives the union of all the employees who are working in D.No. 5 or are supervisor for the employee who are working in D.No.5.

21. (d)

$\pi_{city}(\text{branch}) - \pi_{city}(\text{property})$ ...(1)

It gives those city names where there is no property.

$\pi_{city}(\text{branch}) - ((1))$

It gives those city names having branch office and at least one property as cities with property have been eliminated.

22. (d)

$R - (S - R)$ is equivalent to *R*.

Except (d), remaining all relational algebra expressions are equivalent.

23. (c)

$\pi_{AD}(R \times S) - \rho_{A \leftarrow B}(\pi_{BD}(R \bowtie_{B=C} S))$

A	D
a	b
a	d
a	e
b	b
b	d
b	e
c	b
c	d
c	e

$-\rho_{A \leftarrow B}$

B	D
a	b
c	d
c	e

=

A	D
a	d
a	e
b	b
b	d
b	e
c	b

$\therefore$ 6 tuples are returned by the given query.

24. (a)

Option (a) is giving those book names and member names combination who have reserved the books and who are lecturers.

25. (c)

R and *S* are two relations

$R(P\ Q\ R_1\ R_2\ R_3)$

$S(P\ Q\ S_1\ S_2)$

(i) $\Pi_P(R \bowtie S)$: The query join the relation *R* and *S* then project the column *P* only.

(ii) $\Pi_P(R) \bowtie \Pi_P(S)$: The query project the column *P* from *R* and *S* and then join these projected columns so this produces same result in (i).

(iii) $\Pi_P(\Pi_{P,Q}(R) \cap \Pi_{P,Q}(S))$: The given query project separately the column *P* and *Q* in both relations *R* and *S*. The intersection produces only these column which are common in both and finally projection produces the result the column *P* so this query is also equivalent to (i) and (ii).