GATE

CS & IT

Database Management System

Relational model and Normal forms

DPP: 3

Q1 Assume a relation schema R with 5 attributes P, Q, R, S, T and the set of FD'S P → RS, Q → RT, T→ Q consider the statements:

S_1: The only candidate key of R is PQ and PT

S_2: The highest normal form satisfied by R is 2NF

Which of the statement is true?

(A) Only S_1 is true

(B) Only S_2 is true

(C) Both S_1 and S_2 and true

(D) Neither S_1 nor S_2 is true

Q2 Assume a relation R = (P, Q, R, S) and a set F of functional dependencies:

F = {PR → S, S → P, S → Q, S → R}, Highest normal form satisfied by the relation R is?

(A) 2NF (B) 3NF

(C) BCNF (D) 1NF

Q3 Consider a relation R(P, Q, R, S, T, U, V, W) with the following functional dependencies:

{RW→V, P→QR, Q→RUW, T→P, U→TV}, then the relation R is in _____.

(A) 1NF (B) 2NF

(C) 3NF (D) BCNF

Q4 Consider a table/Relation R has one candidate key, then which of the following is always true?

(A) If R is in 2NF, then it is also in 3NF

(B) If R is in 3NF, then it is also in BCNF

(C) If R is in 2NF, but it is not in 3NF

(D) None of the above.

Q5 Consider a relation R(P, Q, R, S, T) with the set of FD's {PQR→ ST and T → QRS} which of the following statements is true?

(A) R is not in 2NF

(B) R is in 2NF but not in 3NF

(C) R is in 3NF but not in BCNF

(D) R is in BCNF

Q6 Consider a relation R (L, M, N, O) with the functional dependencies:

L → M,

M → N,

N → O

which one of the following decompositions is not lossless?

(A) R_1 (L, M), R_2(M, N), R_3 (N, O)

(B) R_1(L, M), R_2(L, N), R_3 (L, O)

(C) R_1(L, O), R_2(M, O), R_3 (N, O)

(D) All of the above are lossless

Q7 Given the relation 'R' with attributes PQRST with set of functional dependencies {P → P Q R S T, Q → R} which of the following is / are true?

(A) R_1(PRST) R_2(QR) are both in BCNF and preserves lossless join.

(B) R_1(PQST), R_2(QR) are both in BCNF and preserves lossless join

(C) R_1(PST), R_2(QR) are both in BCNF and preserves lossless join.

(D) None of the above.

Q8 Assume a relation R(P, Q, R, S, T, U) with the following dependencies

1. PQ → RS 2. T → R 3. Q → TU

Given the functional dependencies as shown above which among the options shows the decomposition of relation R is normalized to 3NF?

(A) R_1(P, Q, R, S, T, U) R_2(T, R) R_3(Q, T, U)

(B) $R_1(P, Q, R, S)$ $R_2(R, T)$ $R_3(T, U, Q)$
(C) $R_1(P, Q, R, S)$ $R_2(R, T)$ $R_3(Q, T, U)$
(D) $R_1(P, Q, S)$, $R_2(T, R)$ $R_3(Q, T, U)$

Q9 Assume a relation R(P, Q, R, S, T) with the following functional dependencies
{PQ → RST, P → R, Q → S}. which of the following decomposition of R satisfies BCNF?
(A) R_1 (P, R), R_2(Q, S), R_3(P, Q, R, S, T)
(B) R_1(P, R), R_2(Q, S), R_3(P, Q, R, T)
(C) R_1(P, R), R_2(Q, S), R_3(P, Q, S, T)
(D) R_1(P, R), R_2(Q, S), R_3(P, Q, T)

Q10 Suppose functional dependency Q → R holds in relation R (P, Q, R, S) which additional FD will make R be in 3NF, but not BCNF?
(A) S → PQ (B) PR → S
(C) RS → Q (D) PS → Q

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Answer Key

Q1	(A)	Q6	(C)
Q2	(C)	Q7	(B)
Q3	(A)	Q8	(D)
Q4	(B)	Q9	(D)
Q5	(A)	Q10	(C)

Hints & Solutions

Q1 Text Solution:

S_1: P → RS, Q → RT, T → Q

$\{PQ\}^+ = \{PQRST\}$, $\{PT\}^+ = \{PQTRS\}$

So, candidate key of R is PQ and PT

Hence, S_1 is true

S_2: False, we have partial dependency in the relation

"Q → R". Hence, the given relation is in 1NF.

Q2 Text Solution:

PR and S are the super key of the relation. LHS of each FD is super key therefore highest normal form satisfied by R is BCNF.

Q3 Text Solution:

RW→V

P→Q

P→R

Q→R

Q→U

Q→W

T→P

U→T

U→V

As we can see in the 3rd FD P→R, P is prime attribute and Q is non-prime attribute, therefore this relation does not satisfy 2NF and higher normal form. So, the highest normal form satisfied by the above relation is 1NF.

Q4 Text Solution:

If there is only one candidate key and relation is 3NF, that means all functional dependency determinants is Candidate key thus relation is in BCNF, Hence, option (b) is true.

Q5 Text Solution:

PQR→ST

T→QRS

$(PQR)^+ = \{P, Q, R, S, T\}$

$(PT)^+ = \{P, Q, R, S, T\}$

Candidate key = {PQR, PT}

PQR→ST

PQR is candidate key therefore PQR→ST

Satisfy BCNF

T→QRS

T → Q

T → R

T → S

Violate 2NF.

So not in 2NF

Q6 Text Solution:

(a) It is lossless because the relations are decomposed based on the FD's and thus each relation has a common attribute which is also the primary key in either of them.

(b) It is also lossless as it has common attribute L in three of them and L is also the key in R_1, R_2, as well as in R_3.

(c) It is a lossy decomposition because the common attribute is O and O is not the key in either of them.

Hence, the correct option is(c).

Q7 Text Solution:

For BCNF decomposition, the relation is created for those FD which violates BCNF property. So relation is made for QR and remove R from relation and create two relation R_1(PQST), R_2(QR) and this decomposition is lossless.

Q8 Text Solution:

For the given FD set, the minimal cover will be:

PQ → R

PQ → S

T →R

Q → T

Q → U

Minimal cover:

PQ → S

T → R

Q → T

Q → U

Candidate key = {P, Q}

PQ → S Satisfy 3NF

T → R does not satisfy 3NF

Q → T does not satisfy 3NF

Q → U does not satisfy 3NF

∴Those which have same left-hand side will make relation.

$R_1(P, Q, S)$ $R_2(T, R)$, $R_3(Q, T, U)$

Q9 Text Solution:

If decomposition is lossless and every individual relation satisfy BCNF, then decomposition satisfy BCNF.

(a) The Decomposition $R_1(P, R)$, $R_2(Q, S)$, $R_3(P, Q, R, S, T)$ is lossless, but individual relation R_3 does not satisfy BCNF because of FD P → R and Q → S.

(b) The Decomposition $R_1(P, R)$, $R_2(Q, S)$, $R_3(P, Q, R, T)$ is lossless, but individual relation R_3 does not satisfy BCNF because of FD P → R.

(c) The Decomposition $R_1(P, R)$, $R_2(Q, S)$, $R_3(P, Q, S, T)$ is lossless, but individual relation R_3 does not satisfy BCNF because of FD Q → S.

(d) The Decomposition $R_1(P, R)$, $R_2(Q, S)$, $R_3(P, Q, T)$ is lossless, and individual relation R_3 also satisfy BCNF. Therefore, this decomposition is in BCNF.

NOTE: If a relation has only two attributes then it is in

BCNF. Therefore R_1 and R_2 is in BCNF in all the options given above.

Q10 Text Solution:

(a) In this, S is the only key, so Q ® R is both a 3NF and BCNF violation.

(b) Here, PQ is the only key, so both FD's are 3NF and BCNF violations.

(c) Here, we can check that the keys are PRS and PQS. Both FD's violate BCNF, but all the attributes are prime, so there can be no 3NF violation.

(d) PS is the only key, so Q ® R violates both normal forms.

Hence, the correct option is (c)