Q.1) Max Marks: 1

Consider the following statements:

I. If relation R has only one candidate key than R is in 3NF but may not be in BCNF.

II. If A, B, C, D are prime attributes of relation R(ABCD). Then relation R is in BCNF.

Which of the following statements are correct?

A Only I

B Only II

C Both I and II

D Neither I nor II — Correct Option

Solution: (D)

Solution: (iv)

I. Consider a relation R(ABCD) with following FD's and one candidate key:

FD = {A -> C, B -> D }

Candidate key = AB

Here R is not even in 2NF due to partial dependencies, therefore, it is neither in 3NF nor in BCNF. Hence, it is not correct.

II. If every attribute is prime it does not necessary that LHS is a key. Consider the following FD's as an example {AB -> D, C -> A, D -> C}. Hence, this is also incorrect.

Hence, neither I nor II is correct.

Q.2) Max Marks: 1

For the schedule S given below, if transaction T1 aborts after the last operation of schedule S, then which of the following statements will be False?

S: R1(x), R2(z), W1(x), R3(x), R2(y), W2(y), W3(x), R3(y), R2(x)

I. First T2 will be rolled back followed by T3 rollback

II. First T3 will be rolled back followed by T2 rollback.

A Only I — Correct Option

Solution: (A)

Solution: (i)

T3 reads item x after the T1 writes x. Thus, first T3 will be rolled back followed by T2 because later T2 reads item x which T3 has written.

B Only II

C Both I and II

D None of the above

Q.3) Max Marks: 1

The minimum levels of B+ tree index required for 5000 keys and order of B+ tree node (P) is 10 are _____ . (Assume P is the max pointer possible to store in B+ tree node)

Correct Answer

Solution: (4)

Solution: 4

Maximum number of keys in B+ tree of order 10 and height H is:

$10^{(H+1)} - 1 = 5000$

$10^{(H+1)} = 5001$

$H + 1 = 4$

$H = 3$

If we consider root at level 1 than level = height + 1

So, number of levels = 4

OR

Since the order is 10, therefore each node can have max 9 keys

At 1st level, key = 9

At 2nd level, key = 10 * 9

At 3rd level, key = 10 * 10 * 9

At 4th level, key = 10 * 10 * 10 * 9

So, total number of levels = 4

Q.4) Max Marks: 1

In a relation., if every attribute is a prime attribute but key may not be simple than the relation is in

A. 1 NF

B. 2 NF

C. 3 NF — Correct Option

Solution: (C)
Solution: (iii)
For a relation R to be in 3 NF, we should have FD's X -> Y such that either X is a super key or Y is a prime attribute. While for BCNF, in every FD X should always be the super key. Hence, we cannot say anything about BCNF without having FD's but it is definitely in 3 NF.

D. BCNF

Q.5) Max Marks: 1

Which of the following statements is True?
I. The problem of testing view serializability is NP-complete.
II. A conflict serializable schedule is always equivalent to one and only one single serial schedule.

A. Only I — Correct Option

Solution: (A)
Solution: (i)
For a conflict serializable schedule, the linear ordering of transactions corresponds to topological sorting of the serialization graph. Since there can be multiple such orderings, multiple equivalent serial schedules may exist.

B. Only II

C. Both I and II

D. None of the above

Q.6) Max Marks: 1

Given the following two schedules
S1: R3(x), R2(x), W2(x), R1(x), R3(y), W3(y), W2(y), W1(x)
S2: R2(x), R3(x), W3(x), W2(x), W2(y), R1(x), W2(x), R3(y)
Which of the following is true about the above schedule S1 and S2?
I. S1 and S2 are conflict equivalent
II. S2 perform blind write but S1 does not.

A. Only I

B. Only II

C. Both I and II

D. None of the above — Correct Option

Solution: (D)
Solution: (i)
I. The schedule S1 is conflict serializable but S2 is not conflict serializable. The sequence for schedule S1 is T3 -> T2 -> T1. While schedule S2 consists of the cycle. Thus, this statement is false.
II. Both the schedule S1 and S2 have written variable y blindly in transaction T2. Therefore statement II is false.

Q.7) Max Marks: 1

For the schedule S :
R1(x), R2(z), W1(x), R3(x), R2(y), W2(y), W3(x), R3(y), R2(x)

Given below, two orderings of commit operations are specified.

I. C1, C3, C2

II. C1, C2, C3

Which of these ordering ensures recoverability of schedule S?

A. Only I

B. Only II

C. Both I and II

D. None of the above. — Correct Option

Solution: (D)

Solution: (iv)

Both the orders are incorrect because T3 reads item y after T2 writes it and T2 reads item x after T3 writes x.

Q.8) Max Marks: 1

Which of the following options are correct for the order of leaf (P_{leaf}) and non-leaf (P) nodes of a B+ tree where search key field is 12 bytes, record pointer is 10 bytes, block pointer is 8 bytes and given block size is 1KB.

A. $P_{leaf} = 51$ and $P = 46$

B. $P_{leaf} = 47$ and $P = 52$

C. $P_{leaf} = 46$ and $P = 51$ — Correct Option

Solution: (C)

Solution: (iii)

For Leaf node:

$= n (key + record\ pointer) + block\ pointer <= 1024\ B$

$= n (12 + 10) + 8 <= 1024$

$= n (22) + 8 <= 1024$

$= n (22) <= 1016$

$= n <= 1016/22$

$= n <= 46.18 = 46$

For Non – leaf node:

$= n (block\ pointer) + (n – 1)\ key\ pointer <= 1024\ B$

$= 8n + (n – 1)12 <= 1024$

$= 8n + 12n – 12 <= 1024$

$= 20n <= 1036$

$= n <= 1036/20$

$= n <= 51.8 = 51$

D. $P_{leaf} = 52$ and $P = 47$

Q.9) Max Marks: 1

Consider the relation R(A,B,C,D,E) with functional dependencies: ABC -> DE and E -> BCD. Which of the following is true.

A. R is in 3NF

B. R is in 3NF but not in BCNF

C. R is in BCNF but not in 4NF

D. None of the above. — Correct Option

Solution: (D)

Solution: (i)

ABC and AE are candidate keys for R. D is non-prime attribute and it depends on the prime key attribute E. Hence it is not in 2NF.

Q.10) Max Marks: 1

Which of the following is correct about B and B+ tree?

A. B-tree is used instead of B+ tree, when sequential access to key values is never required.

B B-tree is used instead of B+ tree, when direct access to key values is required without sequential access. Correct Option

Solution: (B)

Solution: (ii)

In B+ tree, all keys and its pointers are stored at leaf level as a linked list. Let <k1, k2> <k3, k4> <k5, k6> are leaf nodes of a B+ tree. If we want data from k2 tot k5, in that case B+ tree is preferable but in B tree, keys might be at a different level so sequential search might not be effective. If we want to search key k4 in B+ tree we have to come to leaf to get the data pointer while in B tree we might get k4 at intermediate node. So, B-tree is used instead of B+ tree, when direct access to key values is required without sequential access.

C B-tree is used instead of B+ tree, when sequential access to key values is required.

D B-tree is used instead of B+ tree, when both direct and sequential access to key values is required.

Q.11) Max Marks: 2

Select the correct answer for the matching of given lists.

List I	List II
1. S2(A), R2(A), U2(A), C2, X1(A), W1(A), C1, U1(A)	a. Conservative 2 PL protocol
2. X1(A), W1(A), U1(A), S2(A), R2(A), U2(A), X2(B), W2(B), U2(B), S1(B), R1(B), U1(B)	b. Strict 2 PL protocol
3. S1(A), R1(A), S2(A), R2(A), X1(B), W1(B), C1, U1(A), U1(B), X2(B), W2(B), C2, U2(A), U2(B)	c. Non- serializable schedule
4. S1(A), X1(B), R1(A), W1(B), C1, U1(A), U1(B), S2(A), R2(A), C2, U2(A)	d. Rigorous 2 PL protocol

A **1 - b, 2 - d, 3 - c, 4 - a**

B **1 - a, 2 - c, 3 - d, 4 - b**

C **1 - c, 2 - b, 3 - d, 4 - a**

D **1 - b, 2 - c, 3 - d, 4 - a** Correct Option

Solution: (D)

Solution: (iv)

1. S2(A), R2(A), U2(A), C2, X1(A), W1(A), C1, U1(A): This schedule is serializable (T2 -> T1). But it is neither rigorous 2 PL nor conservative because T2 has unlocked the shard lock on A before committing the operation. Hence, it is having strict 2PL.
2. X1(A), W1(A), U1(A), S2(A), R2(A), U2(A), X2(B), W2(B), U2(B), S1(B), R1(B), U1(B): This schedule is not serializable as there are conflicts in between T1 and T2. There is W1(A) -> R2(A) as well as W2(B) -> R1(B) conflict, therefore it forms a cyclic precedence graph. Hence, it is not serializable.
3. S1(A), R1(A), S2(A), R2(A), X1(B), W1(B), C1, U1(A), U1(B), X2(B), W2(B), C2, U2(A), U2(B) : It is not in coservative 2PL because it has started performing operation before acquiring all the locks and has released all the locks (both shared and exclusive) after committing all the operations. Hence, it is rigorous 2PL.
4. S1(A), X1(B), R1(A), W1(B), C1, U1(A), U1(B), S2(A), R2(A), C2, U2(A): It is conservative 2PL as it has acquired all the lock before starting any operation and has released all locks after committing every operation. Hence, it is having conservative 2PL.

Hence, the correct option is: 1 - b, 2 - c, 3 - d, 4 - a.

Q.12) Max Marks: 2

Consider a relation S = (A, B, C, D, E) with multivalued dependencies { A ->-> B, B ->-> D}. Suppose R contains the tuples (0,1,2,3,4) and (0, 5, 6, 7, 8). Which of the following tuples is not required to be added in R?

A (0, 1, 6, 7, 4)

B (0, 1, 6, 8, 4) Correct Option

Solution: (B)
Solution: (ii)
First, consider the two given tuples. Try to apply the given MVDs to any pair of tuples that have the same values for the attributes on the left side of the MVD. Each application of an MVD lets you add two tuples to the relation: the tuples formed by swapping the values for the attributes on the right side of the MVD. This can be done using the formal definition of an MVD. Repeat this process until all of the tuples implied by the MVDs are already in the relation.

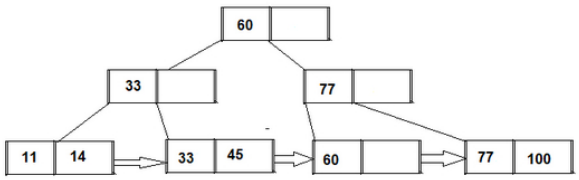
Based on the above procedure, the tuples which should be in relation R based on the given FD's is:
For FD A ->-> B:
Combination of A and B i.e 0 and 1 with a D value as 3 as well as with 7.
Combination of A and B i.e 0 and 5 with a D value as 3 as well as with 7.
Out of the given options, the combination of A, B, and D as 0, 1 and 3 is repeated which is already present in the relation. Thus only that tuple is not required to be added into the relation R, other than that we can add the rest of the 3 tuples in R.

C (0, 1, 2, 7, 8)

D (0 , 5, 6, 3, 8)

Q.13) Max Marks: 2

For the given B+ tree with order 3, what is the minimum number of node splits possible after the following sequence of operations: " Insert 55; Delete 33"



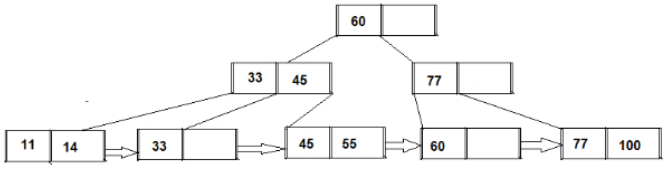
A 2

B 1 Correct Option

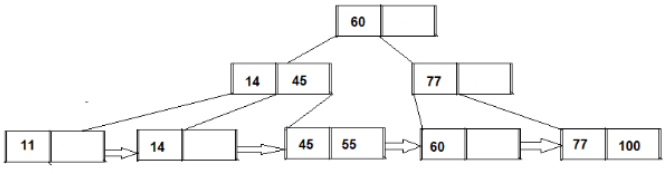
Solution: (B)

Solution: (ii)

Step 1: inserting 55:



Step 2: Deleting 33:



So in total there is only one split. Therefore, correct option is (ii)

C 0

D None of the above

Q.14) Max Marks: 2

Consider a relation r with set of functional dependencies F, and another relation S with another set of functional dependencies G. The highest normal forms of one of the relation are 2 NF, while for the other is BCNF. It is not known that whether R or S is in which normal form. Which of the following is correct for the above situation?

one of the relation are 3 NF, while for the other is BCNF. It is not known that whether R or S is in which normal form. Which of the following is correct for the above situation?

I. To make a correct identification using a single test we can check for Dependency preservation on the relations.

II. To make a correct identification using a single test we can check for 3 NF definition on the relations.

III. To make a correct identification using a single test we can check for BCNF definition on the relations.

A. Only I and II

B. Only II

C. Only III — Correct Option

Solution: (C)

Solution: (iii)

This is because the relation whose highest normal form is 3NF will fail the BCNF test, but both will pass the 3NF test.

D. None of the above

Q.15) Max Marks: 2

What is the maximum number of nodes in B+ tree possible with order 4 and height 5 is _____

Correct Answer

Solution: (1365)

Solution: 1365

B+ tree with order 4 means that at maximum we can have 4 block pointer in a node while minimum is 2. For getting maximum number of node, we need to utilize maximum possible block pointer as a node in the next levels. So the tree will be like:

Level	Maximum nodes	Maximum block pointers
0	1 //root node	4
1	4	4*4=16
2	16	16*4=64
3	64	64*4=256
4	256	256*4=1024
5	1024	1024*4=4096
Total nodes	1365	

The height of the node is the number of edges on the longest path from the node to a leaf. So we have taken upto 5^{th} level, so this way root to leaf, number of edges will be 5 and maximum number of nodes will be 1365.

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