A.

1. Are foreign keys allowed to have null values?
    a) No, foreign keys should have always a concrete value
    b) No, because the value of a key should be unique for any instance of a relation
    c) Yes, because there are situations in which such kind of information is not available
    d) Yes, foreign keys have always null values.

2. What is *logical data independence*?
    a) Changes made in physical schema of a database will not affect the conceptual schema
    b) Changes made in user interface will not affect the conceptual schema
    c) Changes made in conceptual schema will not affect the data access module.
    d) Changes made in conceptual schema of a database will not affect the external schemas

3. Which of the following is not a criteria to use databases for your software system?
    a) Preserve data integrity
    b) Huge amount of structured data
    c) Low-level data access
    d) Persistence

4. Which of the following statements about dense-sparse indexes is *false*?
    a) A dense index must be clustered.
    b) A dense index has at least one data entry for every search key which appears in the indexed fi
    c) A sparse index is typically much smaller than a dense index.
    d) A sparse index is contains an entry for each page of records in a data file.

5. Which of the following definitions is not an alternative of data entries in index files?
    a) <search_key, data record>

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5. Which of the following definitions is not an alternative of data entries in index files?
   a) <search key, data record>
   b) <search key, primary key>
   c) <search key, record ID>
   d) <search key, list of record IDs>

6. The correct hierarchy of terms from largest to smallest is:
   a) field, record, table, database
   b) record, table, database, field
   c) database, table, field, record
   d) database, table, record, field

7. The purpose of a table is to:
   a) Present a document that can be posted on the internet
   b) Present a document in a professional fashion so it can be printed
   c) Store data about an entity type
   d) Answer a question about the database

8. In SQL, if is needed to display records from lowest to highest value, which one of the following commands will be used?
   a) Sort ascending
   b) Remove filter
   c) Sort descending
   d) Referential integrity

Q_1: SELECT DISTINCT R.B FROM R LEFT OUTER JOIN S ON R.B = S.A
Q_2: SELECT DISTINCT S.A FROM R RIGHT OUTER JOIN S ON R.C = S.D

a) Q_1 and Q_2 have the same number of tuples
b) Q_1 and Q_2 have different number of tuples
c) Number of tuples in Q_1 cannot be computed
d) Number of tuples in Q_2 cannot be computed

12. Consider the following relation and functional dependencies:

$$S (A, B, C, D) \qquad \{A \rightarrow BCD, C \rightarrow AB\}$$

Which is the list of all candidate keys?
a) A
b) A, C
c) AC
d) AB

13. Which of the following best characterizes a balanced tree?
a) All leaves are on the same level
b) Leaves are positioned on at most 2 levels
c) For each node the difference between its sub-trees heights is 1, 0 or -1
d) All paths from root to leaves have the same length

14. Who is responsible for unpinning a page in buffer pool?
a) The buffer manager
b) The requestor of that page
c) The frame which contains the page
d) The replacement policy

15. The following SQL queries refer to relations R(a; b) and S(b; c):
Q_1: SELECT * FROM R INNER JOIN S ON R.b = S.b;
Q_2: SELECT * FROM R LEFT JOIN S ON R.b = S.b;

a) Q_1 and Q_2 produce the same answer.
b) The answer to Q_1 is always contained in the answer to Q_2.
c) The answer to Q_2 is always contained in the answer to Q_1.
d) Q_1 and Q_2 produce different answers.

9. Which of the following is not an alternative of mapping inheritance relationship between 2 classes A and B in tables from relational model?
   a) Create table A and de-normalize all attributes of B
   b) Create tables A and B, with their own attributes
   c) Create table B and de-normalize all attributes of A
   d) Create tables A, B and a cross-table between them.

10. Which of the following decompositions of the schema {A, B, C, D, E, F} are dependency preserving decompositions under the given functional dependencies?
    a) {A, B, C, D, F} and {B, C, D, E}: given ABC → DEF, BC → EF and EF → B
    b) {A, B, C, D, F} and {B, C, D, E}: given AB → CDE, DE → CF and C → E
    c) {A, B, C, D, F} and {B, C, E}: given ABC → DEF, BC → E and C → B
    d) {A, B, C, D, F} and {B, E, F}: given ABC → DEF, BC → F and EF → B

11. Given two relations,

R:

A	B	C
1	2	3
1	2	4
3	3	5

S:

A	D
1	4
1	7
3	8

and the following queries:
   Q_1: SELECT DISTINCT R.B FROM R LEFT OUTER JOIN S ON R.B = S.A
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16. In the following, you may assume relations R(a; b) and S(b; c) have no NULL's, but may have duplicates.

(i) SELECT R.a FROM R, S
   WHERE R.b = S.b;
(ii) SELECT R.a FROM R
   WHERE R.b IN (
   SELECT S.b FROM S);

a) Q_1 and Q_2 produce the same answer.
b) The answer to Q_1 is always contained in the answer to Q_2.
c) The answer to Q_2 is always contained in the answer to Q_1.
d) Q_1 and Q_2 produce different answers.

17. In the following, the results of Q_1 and Q_2 should be taken to be the result of the final SELECT * FROM R. Assume that the schema of relation R is R(a; b).

(i) UPDATE R SET b = 20 WHERE a = 10;
   SELECT * FROM R;
(ii) DELETE FROM R WHERE a = 10;
   INSERT INTO R VALUES (10,20);
   SELECT * FROM R;

a) Q_1 and Q_2 produce the same answer.
b) The answer to Q_1 is always contained in the answer to Q_2.
c) The answer to Q_2 is always contained in the answer to Q_1.
d) Q_1 and Q_2 produce different answers.

18. In the following, R has attribute b, but its schema is otherwise not specified, nor is it relevant.

(i) SELECT COUNT(DISTINCT b) FROM R;
(ii) SELECT COUNT(b) FROM R;

a) Q_1 and Q_2 produce the same answer.
b) The answer to Q_1 is always contained in the answer to Q_2.
c) The answer to Q_2 is always contained in the answer to Q_1.
d) Q_1 and Q_2 produce different answers.

19. In the following expressions of relational algebra, the relation R has schema R(a; b).

(i) $\pi_a(R) \times \pi_b(R)$
(ii) $\pi_{a,b}(R \bowtie_{b=b'} \sigma_{b'=a, b=a}(R))$

a) Q_1 and Q_2 produce the same answer.
b) The answer to Q_1 is always contained in the answer to Q_2.
c) The answer to Q_2 is always contained in the answer to Q_1.
d) Q_1 and Q_2 produce different answers.

20. In the following the relations are R(a; b) and S(c;d).

(i) SELECT a
   FROM R
   WHERE b >= ALL(SELECT d FROM S WHERE c=5);
(ii) SELECT a
   FROM R
   WHERE b >= ANY(SELECT d FROM S WHERE c=5);

a) Q_1 and Q_2 produce the same answer.
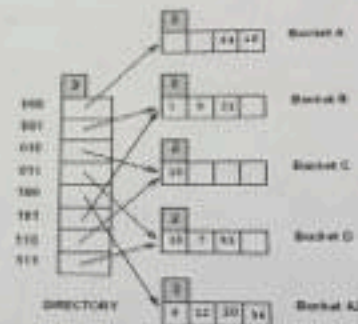b) The answer to Q_1 is always contained in the answer to Q_2.
c) The answer to Q_2 is always contained in the answer to Q_1.
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A. (40%)

1	6	11	16
2	7	12	17
3	8	13	18
4	9	14	19
5	10	15	20

B. (15%) Consider the Extendible Hashing index shown below. Show the index after inserting with hash values 17 and 9.

C. (30%) Consider the following relation and its set of functional dependencies:

S (A, B, C, D, E, F, G)   {A → BC, ABC → D}

a) List all of the candidate keys.
b) Give the minimal cover of the set of functional dependencies.
c) Name the strongest normal form that is not violated by the relation containing attributes.
d) Decompose R into a collection of BCNF relations if it is not in BCNF.

D. (15%) Assume that you are given a relation schema R(A,B,C,D). Assume that n NULL values. Write an SQL query that checks whether the functional dependency holds.

3

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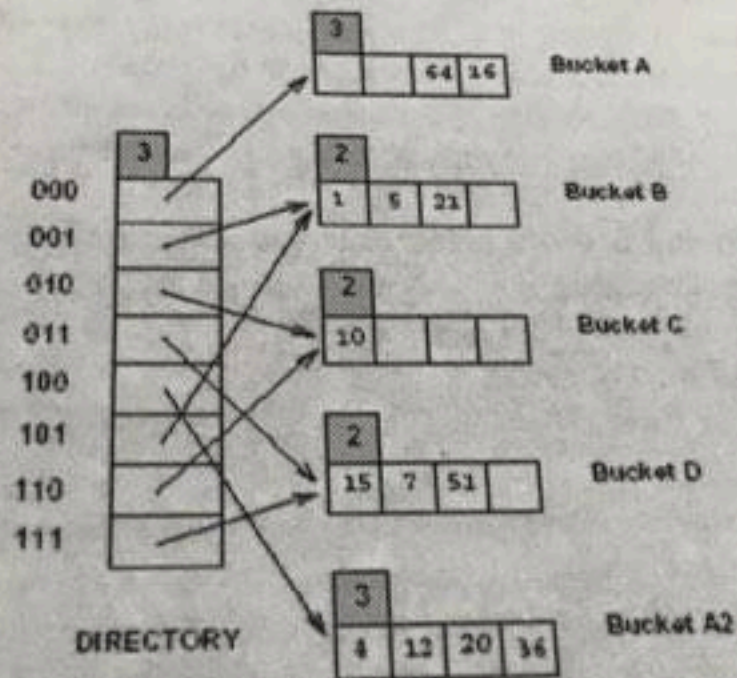
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d) Decompose R into a collection of BCNF relations if it is not in BCNF

D. (15%) Assume that you are given a relation schema R(A,B,C,D). Assume that no record has NULL values. Write an SQL query that checks whether the functional dependency AC → BCD holds.

10		15		20	

B. (15%) Consider the Extendible Hashing index shown below. Show the index after inserting entries with hash values 17 and 9.

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