Indian Statistical Institute

M.Tech. (CS), Mid-Semester of Second Semester Examination, 2024-25

Database Management Systems

Full Marks: 30 Date: 25-02-2025 Time: 2 Hours

Answer any *three* of the following questions

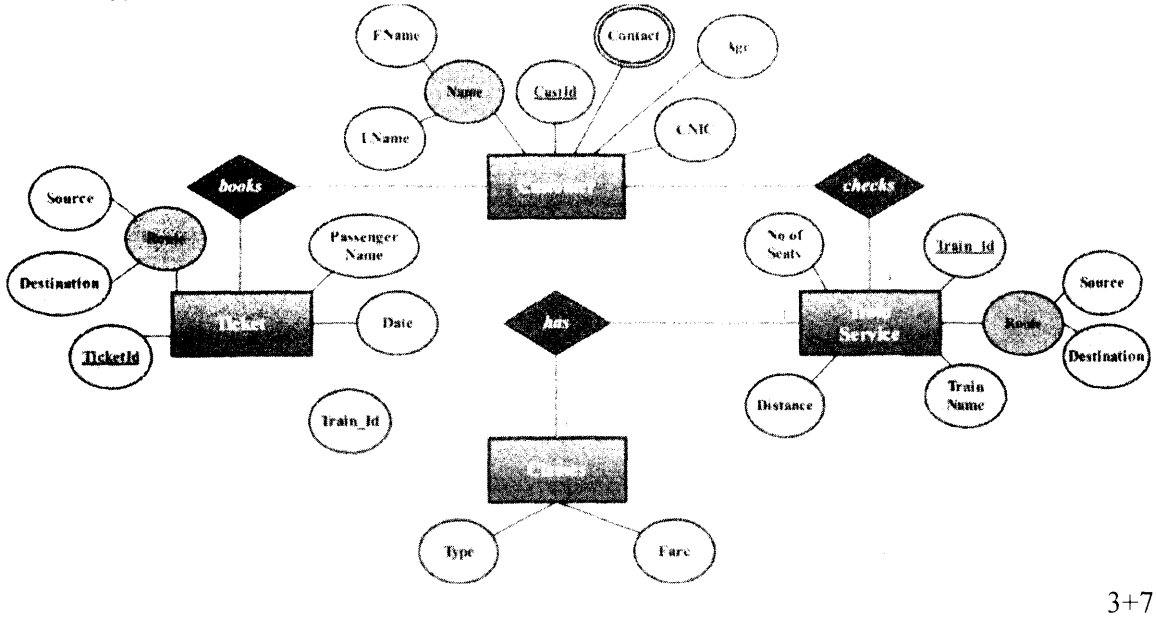
$3 \times 10 = 30$

1. (a) Consider a relation $R = < X, Y, Z >$ having t tuples such that $\text{dom}(X) \subset \text{dom}(Y) \subset \text{dom}(Z)$, where $\text{dom}(A)$ represents the domain of values for the attribute A. What will be the minimum and maximum number of tuples returned by results of the following relational algebra expressions.
   (i) $\pi_{X, Y, Z}(R)$
   (ii) $\pi_{X, Y}(R) \bowtie \pi_{Y, Z}(R)$
   (iii) $R \div \pi_{X, Z}(R)$

   (b) Prove or disprove the statement: "If the natural join and full outer join between a pair of relations R_1 and R_2 results in the same relation, then their semijoin operation is associative, i.e., $R_1 \ltimes R_2 = R_2 \ltimes R_1$". Recall that semijoin is alike natural join with the only exception that attributes in the first relation are returned in the result.

(2+2+2)+4

2. Consider the following Entity Relationship (ER) diagram that depicts a railway reservation system. The customers can avail the train service by checking the train and route details and through booking of tickets. Revise this ER diagram by adding specialization of tickets as "General" and "Tatkal" therein. Finally, convert the revised ER diagram into a set of tables with appropriate constraints incorporated therein.



3+7

3. (a) Consider the following table denoting some employees of a company. Suggest an indexing strategy for the given table. Justify your answer with respect to the different access methods that are applicable on this table.

Name	Age	Salary	Ethnicity	Gender
Suraj	25	40k	Asian	Male
Scott	31	60k	European	Male
Bob	45	70k	American	Male
Shobha	23	110k	Asian	Female
Irwin	28	60k	European	Male
Madhu	30	40k	Asian	Male
Britney	35	60k	European	Female
Chris	38	70k	European	Male

(b) Suppose a relation $R = <A, B, C, D>$ is indexed using a hash table. Justify whether the following operations will be efficient on the relation or not.

(i) $\sigma_{(A > 99) \wedge (A < 999)} (R)$

(ii) $\sigma_{D != 1000} (R)$

6+(2+2)

4. Let there be a relation $R = <U, V, W, X, Y, Z>$ having all the attributes as atomic and holding the functional dependencies FD = $\{X \rightarrow YZ, Y \rightarrow W, U \rightarrow V\}$. Answer all the following questions with proper justifications.

(a) What is the candidate key of R?

(b) What is the highest normal form that R satisfies?

(c) Decompose R such that every decomposed subrelation of R satisfies the Boyce-Codd normal form.

(d) Is your decomposition lossless?

(e) Is your decomposition dependency preserving?

1+1+4+2+2
