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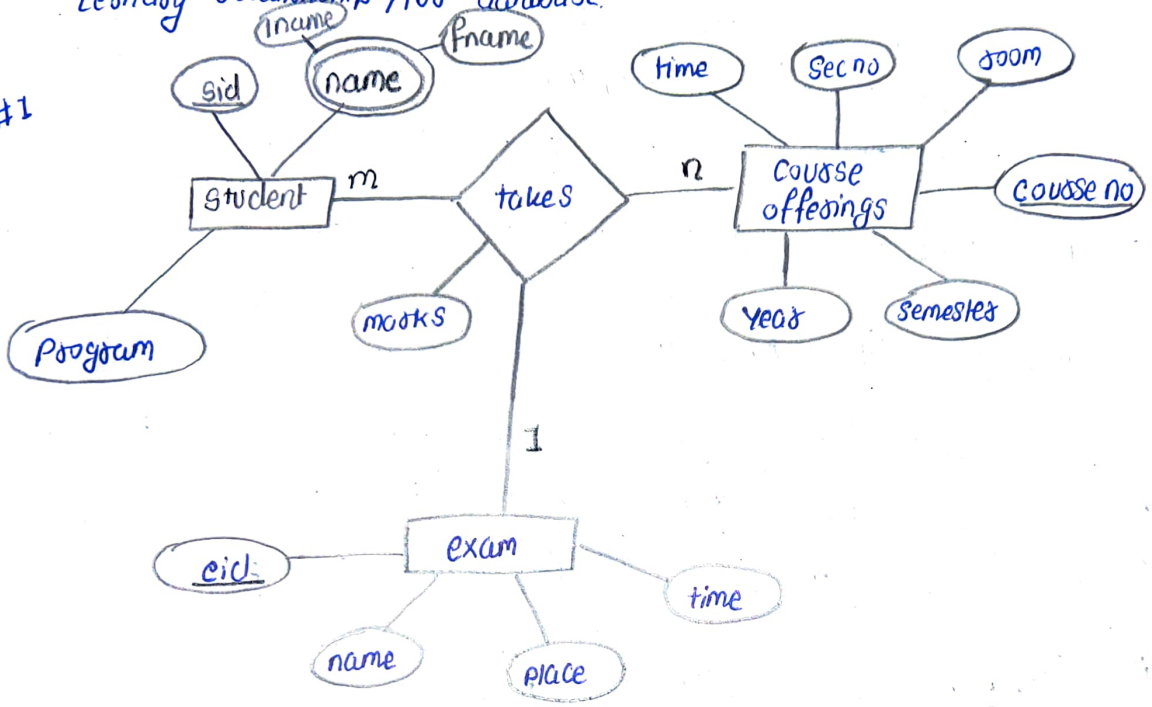
Roll No: 1906055
Branch: CSE-1
Course: Database Management Systems

Course Code: CS5401
Date: 20/12/2021

Solution 1)

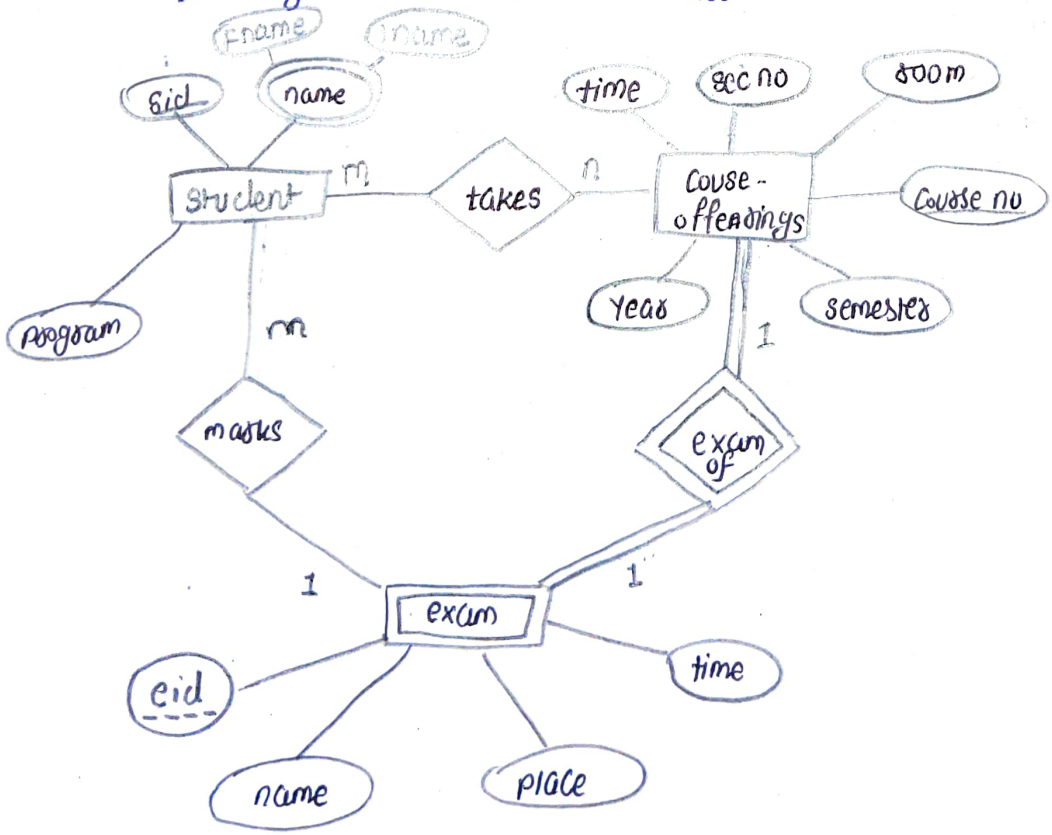
i) To construct an E-R diagram that models exams as entities, and uses a ternary relationship, for database.

#1



E-R diagram for marks database

#2.



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Solution 17

b7.

i) $\sigma_{year \geq 2009}$ (takes) ⋈ Student.

a. For each student who takes at least one course in 2009, display the students information along with the information about what courses the student took. The attributes in the result are:

ID, name, dept, course-no, section-id, semester, year, grade.

ii) $\sigma_{year >= 2020}$ (takes ⋈ Student)

→ Firstly, we perform natural join over tables takes & student (based on common columns) and then selecting the rows/tuples from new table (after natural join) which satisfy the condition year >= 2020.

iii) $\Pi_{id, name, course\_no}$ (Student ⋈ takes)

- Firstly we are naturally joining tables student & takes (based on common column) then from new table selecting all rows of only three columns id, name, course_no.

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Solution 2)

a) Given relations:-

Department (dname, building, budget)

Faculty (fid, name, dname, salary)

Insertion:

Foreign key: dname

Tuple for e.g. (in faculty)

(1000, Ramesh, Bioscience, 60,000)

- Can cause violation because Bioscience may not be present in department table.

- Similar example can be:-

In faculty, insertion of (1001, Rahul, Mathematics, 50,000) where mathematics department is not present in department table.

For Deletion:

In department table, deletion of a tuple which is refereed by a tuple of faculty can cause cause violation.

E.g. Deletion of ("CSE", "New Building, 100 000) where CSE faculty are present in faculty table.

Similarly, deletion of ("Electrical", "Old building", 500000) where faculties of Electrical Department are present in faculty table.

This violation can be solved with using deletion with cascade.

Solution 2)

b)

Employee (ename, Street, City)

Works (ename, cname, Salary)

Company (cname, City)

Manages (ename, manager_name)

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Solution 2> b> Continue..

i> modify database so that Ravi now lives in patna.

```
Update Employee Set City = 'patna' where ename = 'Ravi';
```

Distinct Approach

ii> Update Works T

```
Set T.Salary = T.Salary * 1.05
Where T.ename in (select ename from Manages)
and   T.salary * 1.1 > 500000
and   T.ename = "ABC bank";

Update Works T
  Set  T.Salary = T.salary * 1.1
  Where T.ename in (select ename from Manages)
  and   T.salary * 1.1 <= 500000
  and   T.ename = "ABC bank";
```

OR

Combined Approach

```
UPDATE Works T
SET T.salary = T.salary *
  ( CASE
      WHEN (T.Salary * 1.1 > 500000) THEN 1.05
      ELSE 1.1
  ) END
WHERE T.ename in (SELECT manages_name from Manages) AND
      T.ename = "ABC Bank";
```

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Solution 3)

1. Functional dependencies satisfied by the relation are as follows:-

a)

i) $A \rightarrow B$

For the tuples $t1(A1, B1, C1)$ and $t2(A2, B2, C2)$, $t1[A] = t2[A] = A1$ and $t1[B] = t2[B] = B1$. Thus, the functional dependency $A \rightarrow B$ is satisfied by the relation.

ii) $C \rightarrow B$

For every unique value of C, there exist a unique value of B.
So, above functional dependency satisfies the relation.

iii) $AC \rightarrow B$

Similarly, above functional dependency also satisfies the relation.

2. Functional dependency which does not satisfy the given relation.

i) $B \rightarrow A$ or $B \rightarrow C$ $\{b1 \rightarrow a1, b1 \rightarrow a2\}$

∴ For every unique value of B there exist different value of A & C.
So, above functional dependency does not satisfy the relation.

ii) $A \rightarrow C$.

$a1 \rightarrow c1$ & $a1 \rightarrow c2$

Same values of a1 give different value of C so above functional dependency does not satisfies the relation.

iii) $C \rightarrow A$

∴ $c1 \rightarrow a1$ & $c1 \rightarrow a2$

Similarly this function dependency also not satisfies the given relation.

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Solution: 3)

b)

$A \to BC$
$CD \to E$
$B \to D$
$E \to A$

Lets start with $A \to BC$ first

we can write it as

$A \to B$ and $A \to C$ ---- (using decomposition)

Now

Since $A \to B$ and $B \to D$

we can say $A \to D$ ---- (using transitivity)

Now

Since $A \to CD$ and $CD \to E$

we can say $A \to E$ ---- (using transitivity)

Also $A \to A$ (using reflexive)

So we have $A \to ABCDE$ from the above steps (using union)

Since $E \to A$ and $A \to ABCDE$

$\therefore E \to ABCDE$ ---- (using transitivity)

Now, since $CD \to E$ and $E \to ABCDE$

$CD \to ABCDE$ ---- (using transitivity)

Since

$B \to D$ and $BC \to CD$ and $CD \to ABCDE$

$BC \to ABCDE$ ---- (using augmentative and transitivity)

Also,

$C \to C$, $D \to D$

$B \to B$, $A \to A$, $E \to E$ (using reflexive)

So we have:

$(A)^+ = ABCDE$

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Solution 3) b)
Continue..

$(B)^+ = BD$

$(C)^+ = C$

$(D)^+ = D$

$(E)^+ = ABCDE$

* Closure A and E contains all the attributes so A and E are candidate keys.

Also

$(CD)^+ \rightarrow ABCDE$

$(BC)^+ \rightarrow ABCDE$

* Also $(BC)^+$ and $(CD)^+$ contains all attributes so (BC) and (CD) are also candidate keys.

Adding any more further to these candidate keys will form super keys

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Solution 4)

a)

Customer → 15000 tuples,

1 block of Customer → 30 tuples

total blocks of Customer = $\frac{15000}{30} = 500$

Sales-order → 10,000 tuples

1 block of Sales-orders → 50 tuples

total blocks of Sales-order = $\frac{10,000}{50} = 200$

Let us assume M pages of memory. If M > 200, the join can easily be done in 500 + 200 disk accesses, using even plain nested-loop join. So we consider only the case where M ≤ 200 pgs

a). Nested loop join:

Using Sales-orders as the outer relation we need 10000 * 500 + 200 = 5000200 disk accesses. If Customer as the outer relation we need 15000 * 200 + 500 = 3000500 disk accesses.

b.) Block Nested loops:

If Sales-orders is the outer relation, we need

$\left[\frac{200}{M-1}\right] * 500 + 200$ disk accesses [M ≤ 200 pages]

if Customer is the outer relation, we need

$\left[\frac{500}{M-1}\right] * 200 + 500$ disk accesses

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Solution 4)

b) $\Pi_{name, title}(\sigma_{dept\_name = "CSE"}(instructor \bowtie (teaches \bowtie \Pi_{course\_id, title}(course))))$

Here dept_name is a field of only instructor table. Hence we can select out the CSE instructors before joining the tables, hence reducing query time.

Optimized Query:

Rule. Using rule of Equivalence 1.

⇒ i.e. $\sigma_{\theta_1 \wedge \theta_2}(E_1 \bowtie_\theta E_2) = (\sigma_{\theta_1}(E_1) \bowtie_\theta (\sigma_{\theta_2}(E_2))$

Applying a selection after doing the theta join causes all the tuples returned by the Theta join to be monitored after the join. If this selection contains attributes from only E_1, it is better to apply this selection to E_1 and join with E_2

∴ applying the above rule and performing selection as early as possible reduces the size of relation to be joined.

$\Pi_{name, title}((\sigma_{dept\_name = "CSE"}(instructor)) \bowtie (teaches \bowtie \Pi_{course\_id, title}(course)))$

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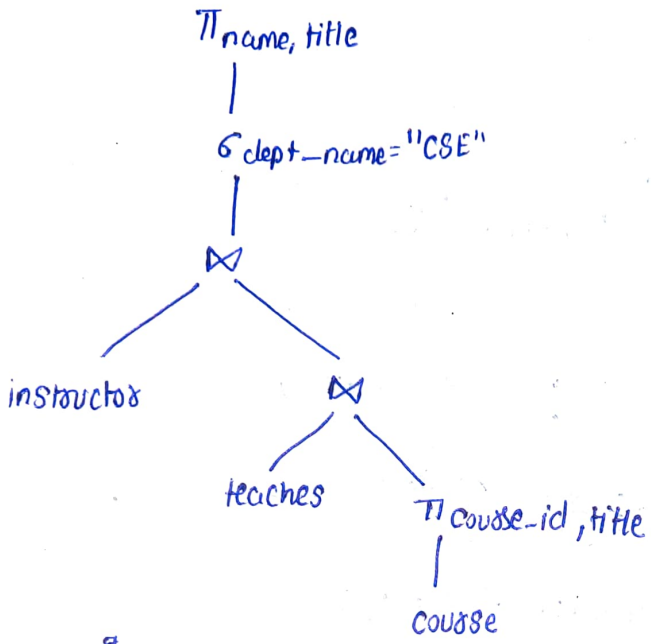
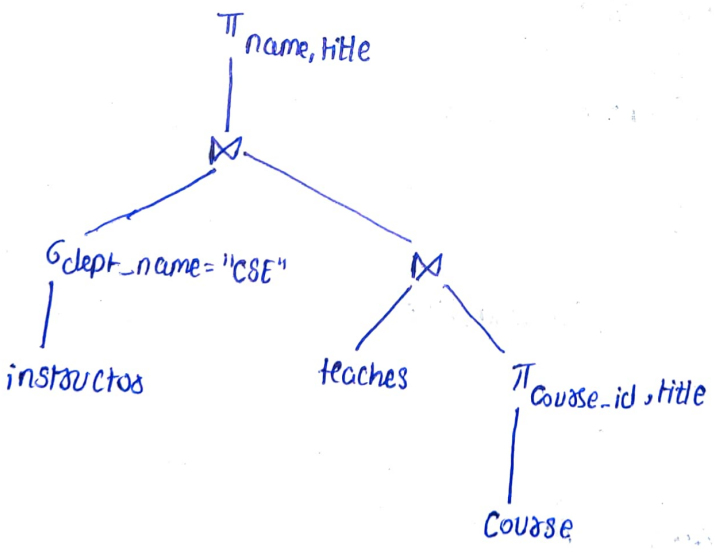
Solution 4) b)

Initial Expression tree



⇒



Transformed Expression Tree

Equivalent Relational Algebra :-

$\Pi_{name, title}((\sigma_{dept\_name = "CSE"}(instructor)) \bowtie (teaches \bowtie \Pi_{course\_id, title}(course)))$