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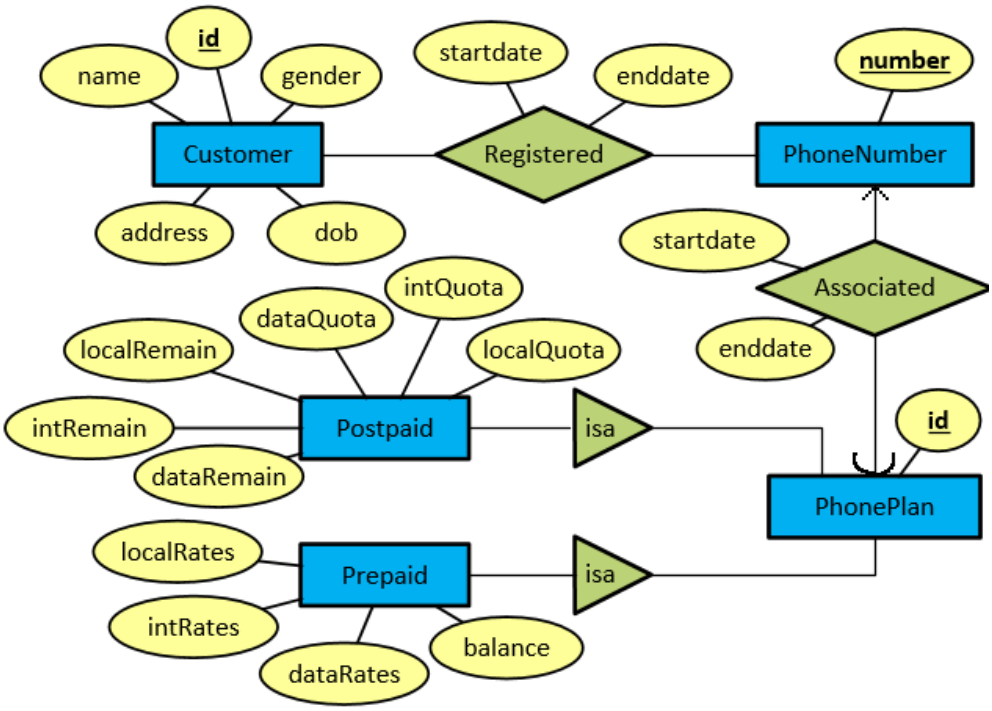
1. (a)
   (i)



   (ii) Customer (**id**, name, gender, dob, address)
   PhoneNumber (**number**)
   Cust_PhoneNum_Registered (**cust_id, number**, startdate, enddate)
   PhonePlan (**id**)
   PhoneNum_PhonePlan_Associated (**number, plan_id**, startdate, enddate)
   Postpaid (**plan_id**, localQuota, intQuota, dataQuota, localRemain, intRemain, dataRemain)
   Prepaid (**plan_id**, localRates, intRates, dataRates, balance)

   (b)

   (i) $R1 := \sigma_{\text{Gender='Female' AND Year}\leq 2015} ACTOR \bowtie MOVIE \bowtie ROLE$
   $R2 := \delta(\Pi_{\text{AName}} R1)$

   (ii) $R1 := \sigma_{\text{Year}\geq 2005 \text{ AND Year}\leq 2015} ACTOR \bowtie MOVIE \bowtie ROLE$
   $R2 := \gamma_{\text{AName, SUM(Pay)}\rightarrow\text{TotalPay, COUNT(MID)}\rightarrow\text{NumOfMovies}} R1$

   (iii) $R1 := ACTOR \bowtie MOVIE \bowtie ROLE$
   $R2 := \delta(\Pi_{\text{AName}} R1)$
   $R3 := \delta\left(\Pi_{\text{AName}}(\sigma_{\text{Profit}\geq 0} R1)\right)$
   $R4 := R3 - R2$

(iv) $R1 \coloneqq ACTOR \bowtie MOVIE \bowtie ROLE$
$R2 \coloneqq \sigma_{\text{Year}=2015} R1$
$R3 \coloneqq \gamma_{\text{AName, SUM(Pay)}\rightarrow\text{TotalPay}} R2$
$R4 \coloneqq \Pi_{\text{AName}}(\sigma_{\text{TotalPay}\geq 1{,}000{,}000} R3)$
$R5 \coloneqq \gamma_{\text{AName, COUNT(MID)}\rightarrow\text{NumOfMovies}} R1$
$R6 \coloneqq \Pi_{\text{AName}}(\sigma_{\text{NumOfMovies}\leq 3} R5)$
$R7 \coloneqq R4 \cap R6$

2. (a)
A does not appear on the RHS of the FDs; thus, A must be included in the keys
$\{A\}^+ = \{A\}$, $\{AB\}^+ = \{ABC\}$, $\{AC\}^+ = \{AC\}$, $\{AD\}^+ = \{ABCDE\}$
$\{AE\}^+ = \{ABCDE\}$, $\{ABC\}^+ = \{ABC\}$
So, keys of R: AD, AE
FD $AB \rightarrow C$ violates BCNF definition. $\{AB\}^+ = \{ABC\}$
Decomposition of R: $R1(A, B, C)$; $R2(A, B, D, E)$
Keys of R1: AB. R1 is in BCNF
Keys of R2: AD, AE. FD $BD \rightarrow E$ violates BCNF definition. $\{BD\}^+ = \{BDE\}$
Decomposition of R2: $R3(B, D, E)$; $R4(A, B, D)$
Keys of R3: BD, E. R3 is in BCNF.
Keys of R4: AD, R4 is in BCNF.
Conclusion: the decomposition of R is $R1(A, B, C)$; $R3(B, D, E)$; $R4(A, B, D)$.
All the FDs are reserved.

(b)
FD $AB \rightarrow C$ violates 3NF definition.
Let $S = \{AB \rightarrow C, AD \rightarrow B, BD \rightarrow E, DE \rightarrow B, E \rightarrow D\}$.
We will determine the minimal basis of S.
After the first 2 steps, S remains the same.
After step 3, $S = \{AB \rightarrow C, AD \rightarrow B, BD \rightarrow E, E \rightarrow B, E \rightarrow D\}$
Hence we ended up with the set $S = \{AB \rightarrow C, AD \rightarrow B, BD \rightarrow E, E \rightarrow BD\}$, which gives the 3NF decomposition of R as $R1(A, B, C)$; $R2(A, B, D)$; $R3(B, D, E)$.

3. (a)
No, They do not always produce the same results.
Query 1 gets a list of all patients' id of whom who has never used any item of the form %digoxin%.
Query 2 gets a list of all the patients' id of whom who has at least once used an item differed from the form %digoxin%.

(b)
(i)
```
CREATE VIEW KeyBranch AS
SELECT branchName, city, assets
FROM BRANCH
```

```
    WHERE branchName IN
      ( SELECT branchName
        FROM ACCOUNT
        GROUP BY branchName
        HAVING SUM(balance) > 1000000 AND COUNT(accountNumber) > 50
      );
```

(ii)
```
CREATE ASSERTION Q3b CHECK (
NOT EXISTS (
  SELECT branchName
  FROM ACCOUNT NATURAL JOIN BRANCH
  GROUP BY branchName
  HAVING SUM(balance) > assets ) );
```

(c)

(i)	
1	1100
2	2200
3	3300
4	4400

(ii)	
1	4400
2	4400
3	4400
4	4400

(d)

`String myQuery = “SELECT name” + “FROM Courses” + “WHERE code = “ + code;` is lack of spacing in between. The correct one should be

`String myQuery = “SELECT name ” + “FROM Courses ” + “WHERE code = “ + code;`

4. (a)

```
SELECT Dnum, Dname
FROM DEPT
WHERE Dnum IN
(
  SELECT DISTINCT Dno
  FROM
    (SELECT DNo, AVG(Salary) AS avgsal FROM EMP GROUP BY DNo)
```

```
  WHERE avgsal =
    (
      SELECT MAX(TMP.avgsal)
      FROM (SELECT DNo, AVG(Salary) AS avgsal FROM EMP GROUP BY DNo) AS TMP
    )
);
```

(b)

(i)

```
    <!DOCTYPE result [
       <!ELEMENT result                (applicants, choices)>
       <!ELEMENT applicants            (applicant+)>
       <!ELEMENT applicant             (#PCDATA)>
       <!ATTLIST applicant             name CDATA #IMPLIED
                                       appNum ID #REQUIRED>
       <!ELEMENT choices               (choice+)>
       <!ELEMENT choice                (#PCDATA)>
       <ATTLIST choice                 applicant IDREF #IMPLIED
                                       code ID #REQUIRED
                                       choiceNum CDATA #IMPLIED
                                       meritScore CDATA #REQUIRED>
    ]>
```

(ii)

```
<results>
    <applicants>
        <applicant name="Doreen" appNum="a1">
            <choice code="MPSOF" choiceNum="1" meritScore="750" />
            <choice code="MPALG" choiceNum="2" meritScore="750" />
            <choice code="MPCSN" choiceNum="3" meritScore="800" />
        </applicant>
        <applicant name="Dilwyn" appNum="a2">
            <choice code="MPALG" choiceNum="1" meritScore="700" />
        </applicant>
        <applicant name="Suzanne" appNum="a3">
            <choice code="MPCSN" choiceNum="1" meritScore="850" />
            <choice code="MPALG" choiceNum="2" meritScore="850" />
        </applicant>
    </applicants>
</results>
```

(c)

(i) `//*[@choiceNum="1"]/[@meritScore>800]`

(ii) `//*[@applicant = //*[@name="Doreen"]/@appNum ]/@code`