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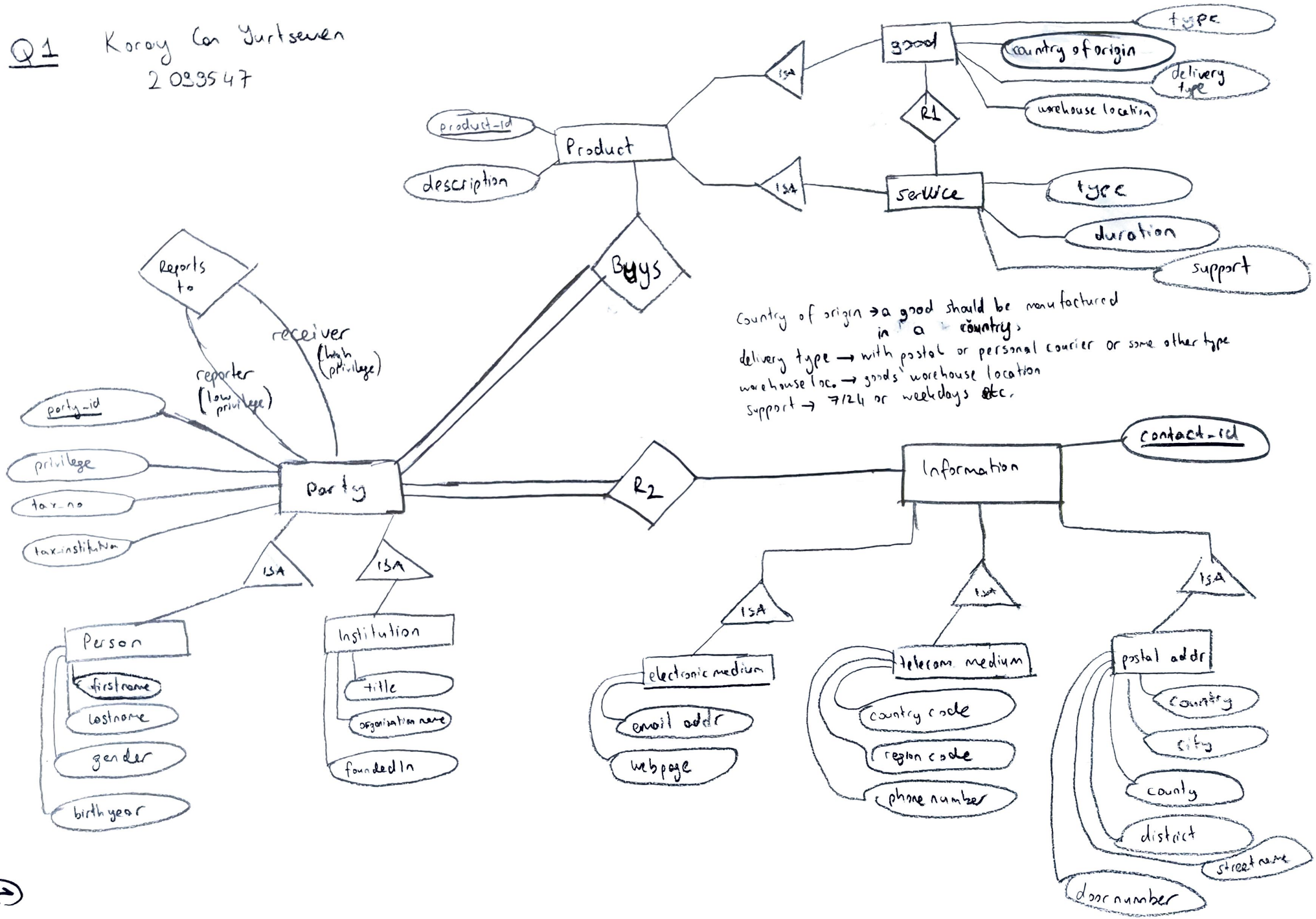

Question 2

a) Tiorian (<u>name</u>);
Gwon (<u>tname</u>, <u>name</u>, liuki);
Calabians (<u>name</u>)
Arehan (<u>name</u> , flightduration, telekinesis)
Elrad (<u>name</u> , invisibility duration , mindreading duration)
R2 (<u>tname</u>, aname)
R3 (tname, ename)
R4 (cname, <u>gname</u>) // Unnamed relation in the E-R diagram

Queries

```
Create Table Tiorian(
    name VARCHAR(255),
    PRIMARY KEY(name));
```

```
Create Table Gwon(
    tname VARCHAR(255),
    name VARCHAR(255),
    liuiki VARCHAR(255) not null,
    PRIMARY KEY(tname,name),
    FOREIGN KEY(tname) REFERENCES
     Tiorian(name));
```

```
Create Table Calabian(
    name VARCHAR(255),
    PRIMARY KEY(name));
```

```
Create Table Arehan(
    name VARCHAR(255),
    flightduration    INT, //in seconds
    telekinesis TINYINT(1), //boolean
    PRIMARY KEY name,
    FOREIGN KEY (name)
      REFERENCES Calabian(name));
```

```
Create Table Elrad(
    name VARCHAR(255),
    invisibilityduration  int, //in seconds
    mindreadingduration   int, //in seconds
    PRIMARY KEY name,
    FOREIGN KEY (name)
       REFERENCES Calabian(name));
```

```
Create Table R2(
    tname VARCHAR(255),
    aname VARCHAR(255),
    PRIMARY KEY (tname),
    FOREIGN KEY (tname)
       REFERENCES Tiorian(name),
    FOREIGN KEY (aname),
       REFERENCES Arehan(name));
```

```
Create Table R3(
    tname VARCHAR(255),
    ename VARCHAR(255),
    PRIMARY KEY (tname,ename),
    FOREIGN KEY (tname)
       REFERENCES Tiorian(name),
    FOREIGN KEY (ename)
       REFERENCES Elrad(name));
```

Question 2

a) Continued

```
CReate Table R4(          //unnamed relation in the ER
    Cname VARCHAR(255),
    gname VARCHAR(255),
    PRIMARY KEY (gname),
    FOREIGN KEY (cname)
      REFERENCES Calabian(name),
    FOREIGN KEY(gname)
      REFERENCES Gwon(name));
```

(Primary Key = P.K.
Foreign Key) = F.K.)

Clarification for tables

- Tiorion table's name field will be unique because of P.K. constraint.
- In Gwon table, the key is (tname, name) pair. This allows us to store same Tiorion's with different Gwons and different Gwons can have the same name.
- The Calabian table is added for R4 relation. If there was no R4 relation we could have omitted this table
- Arehand Etrad tables: Uniqueness will be checked by P.K. constraints.
- R2 relation: Since a tiorion can be at most one in this relation, we can take tname as a key.

t1	a1
t2	a2
t3	a2
t1	a4

→ is allowed

X is not allowed

- R3 relation: Since there is no restriction about "at most one", we can do this table by many to many relation.
- R4 relation: In the E.R., there is an arrow, meaning that a gwon can be "at most one" in this relation. That's why gwon name is key in this relation.

As a side note → If the description is correct, it means a gwon can be present in this table more than once. Then, R4's P.K. should be (gname, cname) pair.

Question 2

b) I did not put R1 relation as a seperate table in my design. the weak entity relation is present in Gwon Table. The rule of "Tirion must have at least one dependent Gwon" can be forced by using Triggers.

c) In R2, we have a constraint which says "a trion may be governed by only one archon." It means that a trion entity cannot be present in this relation more than 1 time. So, I choose tname as P.K. of this table. On the other hand, in R3, we don't have such condition It is many to many relation and (tname, ename) pair will be the key.

Question 3

a) $A^+ = AB$
$B^+ = B$
$C^+ = C, A, B$
$D^+ = D, F$
$E^+ = F$
$F^+ = F$
no keys

$AB^+ = AB$
$AC^+ = ABC$
$AD^+ = AB, D, F$
$AE^+ = A, B, E$
$AF^+ = A, B, F$
no keys

$BC^+ = BCA$
$BD^+ = B, D, F$
$BE^+ = B, E$
$BF^+ = B, F$
no keys

$\boxed{CD^+ = C, D, E, A, B, F}$
$CE^+ = C, A, B, E$
$CF^+ = C, A, B, F$

If we continue like this, we'll see that CD is the only key.
(Since there is no C or D in r.h.s.)

b) It is not in BCNF. Key is CD.

$C \to A$ X
$CD \to E$ ✓
$A \to B$ X
$D \to F$ X

→ violates. They are either part of key, or they have nothing to do with key.

c) Pick $C \to A$
$C^+ = C, A, B$

$R(ABCDEF)$

$R_1(CAB)$
$C \to A$
$A \to B$
key is C

$R_2(CDEF)$
$CD \to E$
$D \to F$
CD is key

in R_1, $A \to B$ violates BCNF
$A^+ = AB$

$R_{11}(CA)$
$C \to A$ ✓

$R_{12}(AB)$
$A \to B$ ✓

in R_2, $D \to F$ violates BCNF
$D^+ = DF$

$R_{21}(DF)$
$D \to F$ ✓

$R_{22}(CDE)$
$CD \to E$
CD is key
✓

So, we decomposed R into
(CA) (AB) (DF) (CDE)

Question 3

d)i) We have preserved dependencies.

On the original R, we have

F: $C \rightarrow A$
$CD \rightarrow E$
$A \rightarrow B$
$D \rightarrow F$

On the final decomposed version, we have

R_{11} (CA) $C \rightarrow A$ ✓

R_{12} (AB) $A \rightarrow B$ ✓

R_{21} (DF) $D \rightarrow F$ ✓

R_{22} (CDE) $CD \rightarrow E$ ✓

ii) It is lossless join because we are using keys.

By definition, BCNF is lossless join.

Q4:

R(ABCDEFGH)

$DE \rightarrow B$

$FD \rightarrow A$

$HAC \rightarrow BC$

$D \rightarrow E$

$FH \rightarrow B$

$A \rightarrow C$

$CF \rightarrow DE$

$FD \rightarrow C$

a)

Step 1, make r.h.s. of each F.D. single attribute

$DE \rightarrow B$

$FD \rightarrow A$

$HAC \rightarrow B$

$HAC \rightarrow C$

$D \rightarrow E$

$FH \rightarrow B$

$A \rightarrow C$

$CF \rightarrow D$

$CF \rightarrow E$

$FD \rightarrow C$

Step 2, try to eliminate attributes from L.h.s.

$DE \rightarrow B$

$D^+ = D, E, B$

remove E

$\boxed{D \rightarrow B}$

$FD \rightarrow A$

$F^+ = F$

$D^+ = DE$

it stays

$HAC \rightarrow B$

$H^+ = H$

$A^+ = A, C$

$C^+ = C$

$HA^+ = HACB$

HAC will be removed

$\boxed{HA \rightarrow B}$

$HAC \rightarrow C$

$C \rightarrow C$

HA will be removed

$C \rightarrow C$ will be removed, trivial

$FH \rightarrow B$

$F^+ = F$

$H^+ = H$

it stays

$CF \rightarrow D$

$C^+ = C$

$F^+ = F$

it stays

$CF \rightarrow E$

stays

$FD \rightarrow C$

$F^+ = F$

$D^+ = DEB$

it stays

$DE \rightarrow B$ transformed to $D \rightarrow B$

$HAC \rightarrow C$ removed

$HAC \rightarrow B$ transformed $HA \rightarrow B$

Now, we have

~~D → B~~

FD → A

HA → B

D → E

FH → B

A → C

CF → D

CF → E

FD → C

Step 3

i) Without D → B, can I obtain B?

$D^+ = D, E$ no, D → B stays

ii) FD → A

$FD^+ = F, D, E, C, B$ (DE → B) no, FD → A stays

iii) HA → B

$HA = H, A, C,$ no, HA → B stays

iv) D → E

$D^+ = D$ D → E stays

v) FH → B

$FH^+ = F, H,$ FH → B stays

vi) A → C

$A^+ = A$ A → C stays

vii) CF → D

$CF^+ = C, F, E$ CF → D stays

viii) CF → E

$CF^+ = C, F, D, (E)$ CF → E can be removed

ix) FD → C

$FD^+ = F, D, A, C$ FD → C can be removed.

Now, we have

D → B

FD → A

HA → B

D → E

FH → B

A → C

CF → D

minimal cover

Question 4 b

Step 4

Group together. Since, we dont have repetitions on L.h.s, there is no need to group.

R_1 (DEB) key is D

R_2 (FDA) key is FD

R_3 (HAB) key is HA

R_4 (FHB) key is FH

R_5 (AC) key is A

R_6 (CFD) key is CF

Step 5

In the original table there is G, but G is not present in tables above.

In the original table the key is DFGH

$DFGH^+ = D, F, G, H, \underset{D \to E}{E}, \underset{BE \to B}{B}, \underset{FD \to A}{A}, \underset{A \to C}{C}$

So, put it in the above

R_0 (DFGH) key is DFGH