總分110 分，最高以100分計

1. Suppose relation R(A, B, C) currently has tuples (1, 2, 5), (2, 2, 4), (3, 4, 5) and relation S(B,C) currently has (2, 5), (3, 5), (4, 6), (7, 8). Please show the tuples in the result of the following SQL queries.

   (a) (5分)

   ```
   SELECT *
   FROM R NATURAL RIGHT OUTER JOIN S;
   ```

   Ans:

A	B	C
1	2	5
null	3	5
null	4	6
null	7	8

   (b) (5分)

   ```
   SELECT *
   FROM R RIGHT OUTER JOIN S ON B;
   ```

   Ans:

A	B	C	B	C
1	2	5	2	5
2	2	5	2	5
null	3	5	3	5
3	4	6	4	6
null	7	8	7	8

2. Consider the following relational schema:

   Account(accountNumber, branchName, balance)

   Branch(branchName, street, city, assets)

   Customer(customerSSN, street, city)

   Deposit(customerSSN, accountNumber, Amount)

   (a) List all the attributes (in the four tables) that are foreign keys and indicate what attributes they are referencing. (4分)

   Ans:

   customer SSN on customer referenced to Deposit's account Number

   account Number on Branch referenced to Deposit's account Number

   foreign key

   -2

(b) Define a view *BigBranch* that gives for each branch its branchName, city, and assets. The branch should have more than 50 accounts and the total balance of all accounts is greater than $1,000,000. (6分)

Ans:

create view *BigBranch* **as**

Select branchName, City, assets
from Account, Branch
where count(Account)
group by
having

-3.5

(6) Is it possible to perform SQL UPDATE/DELETE/INSERT statements on top of the *BigBranch*. Why? (5分)

Ans:

不行，因為view僅是一reference to Physical Table，所以view本身僅是virtual table

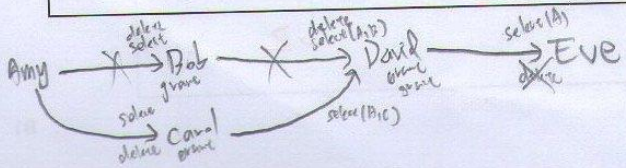
3. Consider a table T(A,B,C) with owner Amy, and the following sequence of statements related to privileges on T. Each statement is prefaced with the user issuing it.

Amy: Grant Select, Delete On T To Bob With Grant Option
Amy: Grant Select, Delete On T To Carol With Grant Option
Bob: Grant Select(A,B), Delete on T to David With Grant Option
Carol: Grant Select(A,C) On T To David With Grant Option
David: Grant Select(A), Delete on T to Eve
Amy: Revoke Select, Delete on T From Bob Cascade

What privileges on table T does Eve have after this sequence of statements? (5分)

Ans:

select(A) on T



4. Consider tables `T1(P,A)` and `T2(F,B)`. This problem explores using triggers to enforce two constraints:

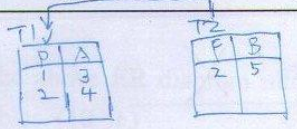
1) *Key constraint on* `T1.P`

2) *Referential integrity constraint from* `T2.F` *to* `T1.P`

To keep things simple, you may assume there are never `null` values for `T1.P`.

(a) List all of the **data modification operations** (update, insert, or delete) on `T1` and `T2` that could cause either the key constraint or the referential integrity constraint to become violated. For `update` operations, include the specific columns. You do not need to associate the operations with which constraint(s) they may affect. (5分)

Ans:



1筆設表T1, T2已經有存一些 tuple

insert T1 values (1,2) 違反 key constraint
insert T2 values (5,1) 違反 referential Integrity
delete T1 where A=4 違反 referential Integrity
update T1 set P=P+1 where A=3 、違反 key constraint
update T2 set P=P+1 、違反 referential Integrity

(b) Next you will specify triggers to enforce the two constraints when column `T1.P` is updated. In this part of the problem, you will specify a row-level `before` trigger for the key constraint and a row-level `after` trigger for the referential integrity constraint. (10分)

- You may assume that when a tuple in `T1` is updated, the new value of `P` in that tuple is different from the old one. Make no other assumptions about the updates.
- For the key constraint, you should execute a special "`raise-error`" command when the constraint is violated. This command will abort the statement that caused the violation.
- For the referential integrity constraint, please implement the "*On Update Cascade*" policy.

Fill in the blanks in the following skeletons. Try to make use of trigger features to enforce the constraints, but without getting overly complex. Note that it is fine to leave some boxes empty, as appropriate. *Please use SQL-99 triggers, not those implemented in a specific system.* (課本的語法)

```
Create Trigger UpdKey
Before Update of P on T1
Referencing (a) as t          /* Hint: new row/old row
For Each Row
When (t.P    (b)
      (select  (c)
       from    (d)    ))
begin
    rollback
end;
```

-3

Ans:

(a) new row

(b) X

(c) X

(d) X

```
Create Trigger UpdRI
After Update of P on T1
referencing new row as nrow
referencing old row as orow
For Each Row
When (     (a)     in (select    (b)
                       from T2)
begin
      update    (c)
      set      (d)
      where     (e)
     end;
```

-5

Ans:

(a) select nrow.P

(b) X

(c) X

(d) X

(e) nrow.P != orow.P

5. Please complete the SQL query that computes the natural full outer-join of relations R(A, B) and S(B, C), without using SQL's outer-join operator. (Hint: the following query returns all tuples in Q(A,B,C) with all B values replaced by NULL: select A,NULL,C from Q). (5分)

(((Select R.A, R.B, S.C
From R, S
Where (a))
Union
(Select R.A, R.B, NULL
From R
Where R.B not in (Select B from S))
Union
(Select (b)
From S
Where (c) not in ((d)))

-1

Ans:

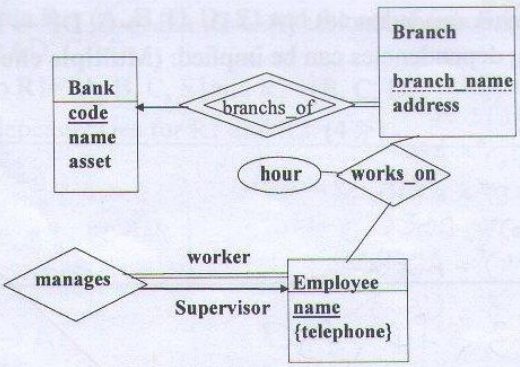
(a) R.B = S.B

(b) R.B, R.C, NULL

(c) R.B

(d) select B from S

6. Consider the ER diagram



Please map the above ER diagram into a relational schema and specify all primary keys and foreign keys in the tables. (10 分)

Bank (code , name , asset)
Branch (code branch_name , address)
branchs_of (code branch_name)
code
works_on (hour , branch_name , name)
Employee (name , telephone)
manages (name , name)
Supervisor worker

-4

7. Consider the follow attributes and functional dependencies:
R=(A, B, C, D, E, F, G)
F={A→ D, AE → G, DF → BC, E → C, G → E}
(a) Find AE^+ and DF^+ (4分)

A→D
AE→G
DF→BC
E→C
G→E

Ans: $(AE)^+ = AEGDC$
$(DF)^+ = DFBC$

AFC
=ADCF
DBC

(b) List all candidate keys of R. (5分)

Ans: AFE

-2

(A)⁺=AD
(B)⁺=B
(C)⁺=C
(D)⁺=D
(E)⁺=EC
(F)⁺=F
(G)⁺=GEC

DFBC
AE
ADE = ADG
ADC = AD
ADG = ADEGC
ADF = ADFBC

A→D
AE→G
DF→BC
E→C
G→E

(c) Given the above function dependencies: {A→ D, AE → G, DF → BC, E → C, G → E}
Which of the following dependencies can be implied: **(Multiple choices question)** (5分)

f1. BC → B $(BC)^+ = BC$
f2. ABC → ADF $(ABC)^+ = ABCD$
f3 AED → C $(AED)^+ = AEDC$
f4 DG → C $(DG)^+ = DGEC$
f5 AF → BC $(AF)^+ = ADFBC$

Ans: f1, f3, f4, f5 ✓

$A^+ = ABCEDF$

A→B
A→C
BC→E
BC→D
E→F
AE→F
BC→F
C→D

8. Consider the relation schema R = (A, B, C, D, E, F) and the set of functional dependencies F: A->B, A->C, BC->E, BC->D, E->F, AE->F, BC->F, C->D $BC^+ = BCEDF$ $E^+ = EF$

a) List the FDs in F that violate BCNF. (4分) $A^+ = ABCEDF$

Ans: $(BC)^+ = BCEDF$ ⇒ BC→E, BC→D, BC→F violate
$(E)^+ = EF$ → E→F violate
$(C)^+ = CD$ ⇒ C→D violate
$(BC)^+ = BCDEF$ → BC→F violate ✓

$C^+ = CD$
$AC^+ = AEFBCDF$
$BC^+ = BCEDF$

b) Is R in 3NF? You have to explain the reason. (4分)

Ans: ∵ candidate key is A
∴ 看任 α → β, $(BC)^+$、$(E)^+$、$(C)^+$、$(BC)^+$ 不是 superkey
也不是 candidate key 的 subset
所以 R is not in 3NF ✓

c) Find the Canonical cover of F. (6分)
F: A->B, A->C, BC->E, BC->D, E->F, AE->F, BC->F, C->D

Ans:
A→BC
BC→E
E→F
C→D ✓

A→BC
BC→EDF
E→F
AE→F
C→D
⇒ A→BC, BC→EDF, E→F, C→D ⇒ A→BC, BC→EF, E→F, C→D ⇒ A→BC, BC→E, E→F, C→D

A→B
A→C
BC→E
BC→AD (→D)

9. Consider the relation schema R = (A, B, C, D, E) and the set of functional dependencies F: A->B, A->C, BC->E, BC->AD, C->D

Suppose R is decomposed into R1={A, B, C, E}and R2={B, C, D}.

a) Please find the projected dependencies for R1 and R2. (4分)

Ans: (R1)
consider A, $(A)^+$ = ABCE, 可導出 A→BCE
consider BC, $(BC)^+$ = BCEAD, 可導出 BC→AE
consider C, $(C)^+$ = CD, but D is not in R1
∴ A→BCE, BC→AE

(R2)
consider BC, $(BC)^+$ = BCEACD, 可導出 BC→D
consider C, $(C)^+$ = CD, 可導出 C→D
∴ C→D, BC→D

b) Does the decomposition preserve the given dependencies? Explain the reason. (2分)

Ans: F' = F1 ∪ F2 = (A→BCE, BC→AE, C→D, BC→D)
可整理為 (A→BCE, BC→AED, C→D)
可導出原 FD, 所以為 decomposition preserving

c) Does the decomposition is a lossless-join decomposition? Explain the reason. (3分)

Ans: ∵ R1 ∩ R2 = BC, 且 BC 是 R1 的 superkey
∴ 為一 lossless decomposition 成立

d) Do both R1 and R2 in BCNF?
If any table is not in BCNF, further decompose the table into 2 tables that satisfies BCNF. (5分)

Ans: (R1) (A, B, C, E)
$(A)^+$ = ABCE
$(BC)^+$ = BCAE
R1 in BCNF

(R2) (B, C, D)
$(BC)^+$ = BCD
$(C)^+$ = CD (C→D violate BCNF)
R2(B, C, D) 可分解
R3 CD (C→D)
R4 BC (F)
R2 可分解為 R3(C, D), R4(B, C)
皆以符合 BCNF

10. Consider the relation schema R = (A, B, C, D, E) and the set of functional dependencies
F: A->B, A->C, BC->E, BC->AD, C->D

R is not in 3NF. Please decompose the relation such that the resultant relations satisfy 3NF. Besides, the composition should be a lossless-join decomposition and remains dependency preservation. (8分)

Ans:

R(A,B,C,D,E), candidate key = A, BC

R(A,B,C,D,E)

因為 C→D 違反 3NF

R1(C,D) C→D

R2(A,B,C,E) BC→E

R(A,B,C,D,E)，拆解成 R1(C,D) 以及 R2(A,B,C,E)

1. C是R1的superkey，BC可做R2的superkey
2. 藉此拆解符合 BCNF

A→B
A→C
BC→E
BC→AD
C→D

$(A)^+ = ABCED$
$(B)^+ = B$
$(C)^+ = CD$
$(D)^+ = D$
$(E)^+ = E$

$(BC)^+ = BCADE$