Abstract
Now it’s time that we make a careful consideration on our schemas derived from the E-R diagram. What are candidate keys for each relation? Are we choosing the correct primary keys? What normal form does each relation belong to? How could we decompose relations so that after a serial of actions all relations are in 3NF or BCNF, while the semantics are precisely preserved?

Question 1
(1) Consider relation R=(A,B,C,D) with the following FDs:
   AB -> C, C-> D, and D-> A
   a. List all candidate keys of R.
   b. Is R in 3NF? BCNF?

(2) Consider relation S=(A,B,C,D) with the following FDs:
   A->B, B->C, C->D, and D->A
   a. List all candidate keys of S.
   b. Is S in 3NF? In BCNF?

(3) Given relation R=(A,B,C,D), find if R is in 3NF or BCNF with respect to the following FDs
   i.   B->C, C->A, C->D
   ii.  ABC->D, D->A
   iii. A->C, B->D
**Question 2**

Create Table r1

(a1 INTEGER, a2 INTEGER, a3 INTEGER, a4, INTEGER, a5 INTEGER,

Primary Key (a1, a2),

Unique (a3, a4),

Foreign Key (a5) references r2 (a5))

1) List all the non-trivial functional dependencies pertaining to the attributes of r1 that can be inferred from the create table statement.
2) Is r1 in BCNF? Give a brief explanation.
3) Is r1 in 3NF? Give a brief explanation.

**Question 3**

*Normalization:*

- Consider a schema with attributes $A_1, A_2, A_3, A_4, A_5, A_6$ and FDs

  $$A_1 \rightarrow A_3, \ A_1A_2 \rightarrow A_3, \ A_3 \rightarrow A_4A_6, \ A_3A_4 \rightarrow A_6, \ A_2A_5 \rightarrow A_1A_2, \ A_5A_6 \rightarrow A_3.$$

(a) Find a minimum cover for this set of FDs.

- Consider another set of FDs on $A_1......A_6$:

  $$A_3 \rightarrow A_6 \ (FD1), \ A_5 \rightarrow A_1 \ (FD2), \ A_3A_5 \rightarrow A_4 \ (FD3), \ A_1 \rightarrow A_2 \ (FD4).$$

(b) How many candidate keys does it have? Explain your answer.
(c) Find a lossless BCNF decomposition of the schema. Is it dependency-preserving? Explain why.
Question 4

[RG 3rd P640. 19.9] Case Study: The Internet shop

The case study is sketched as follows:
A design for an online book store with the following E-R diagram:

And a possible relational schema:

Books (isbn, title, author, qty_in_stock, price, year_published)
Customers (cid, cname, address)
Orders (order_no, isbn, cid, card_no, qty, order_date, ship_date)

Tasks:
1) Examine this schema and suggest reasonable functional dependencies;

Note: your answers to the next two parts will depend on your answer to 1)
2) Decompose the relations into BCNF;
3) Draw the E-R diagram reflecting the final design.