一、Single Choices. (Choose only one best answer for each. 10 Marks)

1. K is a （ ） of r(R) if the functional dependency K→R holds on r(R).

   (A) superkey

   (B) candidate key

   (C) primary key

   (D) foreign key

2. In the following series, （ ） is 2PL.

   (A) Lock-X(U)…Lock-S(V)…Lock-S(W)…Unlock(U)…Unlock(W)…Unlock(V)

   (B) Lock-X(U)…Unlock(U)…Lock-S(V)…Unlock(V)…Lock-S(W)…Unlock(W)

   (C) Lock-X(U)…Lock-S(V) …Unlock(U)…Unlock(V)…Lock-S(W)…Unlock(W)

   (D) Lock-X(U)…Unlock(U)…Lock-S(V) …Lock-S(W)…Unlock(W)…Unlock(W)

3. If a transaction acquires the exclusive lock on a data item Q, it can （ ）.

   (A) read Q only

   (B) write Q only

   (C) both read Q and write Q

   (D) neither read Q nor write Q

4. Which of the following is not property of transactions? （ ）

   (A) Atomicity

   (B) Isolation

   (C) Durability

   (D) Serializability

5. Which of the following statement(s) is(are) true? （ ）

   I. 4NF implies BCNF

   II. BCNF implies 3NF

III. 3NF implies BCNF

(A) None

(B) I only

(C) I and II

(D) I and III

二、Briefly-answer questions. (10 Marks, 5 Marks for each.)

1. What is the Two-Phase Locking Protocol (2PL)?

2. What are serializable schedules?

三、Relational Algebra and SQL. (32 Marks, 4 Marks of each)

Consider the following relational schemas about a car insurance system, the primary keys are underlined:

car (plate_number, model, brand, owner)

accident (aid, accident_time, place, detail)

c_a (plate_number, aid, compensation)

Give a relational algebra expression for each of the following queries:Find the names of all salespeople that have an order with Samsonic. (Marks: 4)

(1) Find plate numbers and owners of all cars involves in the accident whose id is "2016-17321" .

(2) Find plate numbers of all cars that never involves in any accident.

(3) Find plate numbers of all cars that involves in all accidents that the car whose plate number is "SC-A1749" involves in.

Write SQL statements in to perform the following instructions.

(1) List the information of all cars with the plate number begin with "SC-A".

(2) List plate numbers of all cars that involves in more than 3 accidents.

(3) List plate numbers of all cars that never involves in any accident.

(4) List plate numbers of all cars that involves in both accident with id "2016-13101" and "2016-14201".

(5) List plate numbers of all cars that involves in all accidents that the car whose plate number is "SC-A1749" involves in.

四、Normalization. (Total marks: 28)

1. Consider the relation Course(C, T, H, R, S, G), whose attributes may be thought of informally as course, teacher, hours, room, student and grade. Let the set of FD's for Course be C→T, HR→C, HT→R,HS→R, and CS→G. Intuitively, the first says that a course has unique teacher, and the second says that only one course can meet in a given room at a given hour. The third says that a teacher can be in only one room at a given hour, and the fourth says the same about student. The last says that students get only one grade in a course.

   (1) What are all candidate keys of Course? (4 Marks)

   (2) Is the relation Course in 3NF, explain why. If it is not, decompose it into 3NF relations. (6 Marks)

2. The following table stores information about instructors and their department in a university.

instructor_department

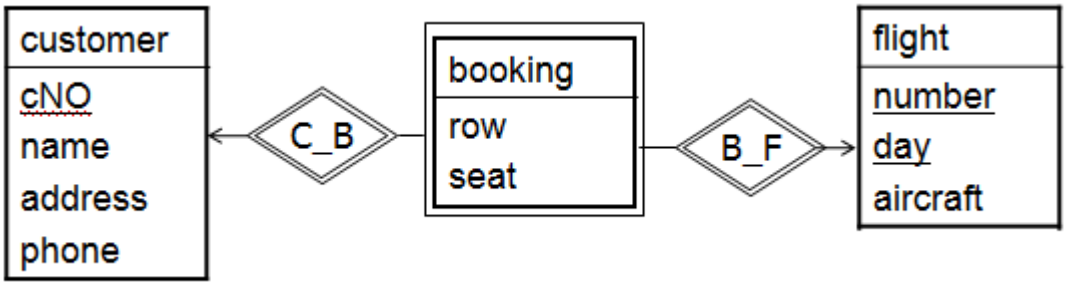
id	name	Salary	dept_name	Budget
12121	Einstein	10000	Physics	80000
12145	Hawking	12000	Physics	80000
13133	Avi	90000	CS	90000

   (1) Identify functional dependencies of the table instructor_department according to your reasonable assumptions. (6 Marks)

   (2) Identify the candidate key(s) of the table instructor_department (4 Marks)

(3) IS the relation schema instructor_department in BCNF? Why? Is it in 3NF? Why? If it is not in 3NF, bring it to a set of relations at least in 3NF; specify primary keys and referential integrity constraints for each relation. (8 Marks)

五、Database Design（Total marks: 20）



1. Consider the above figure, which models an airline booking system. Convert the E-R diagram to 3NF relations. Specify keys and referential integrity constraints. (Marks:10)
2. Design a database for a world-wide package delivery company (e.g., DHL or FedEX). The database must be able to keep track of customers who ship items and customers who receive items; some customers may be both. Each package must be identifiable and trackable, so the database must be able to store the location of the package and its history of location. Locations include trucks, planes, airports, and warehouse

   Design an E-R diagram that captures the information above. (Mark: 10)