Mid-Term Examination
CS354: Databases
Full Marks: 60 Time: 2 hours

Note: Make assumptions if necessary.

(1) Answer the following questions: **(15 + 5 + 4 + 8 = 32 points)**

a. Draw an ER Diagram for Banking Enterprise based on the following requirements:
   - The bank is organised into branches. Each branch is located in a particular city and is identified by a unique name. The bank monitors the assets of each branch.
   - Bank customers are identified by their customer_id value. The bank stores each customer's name, and the street and the city where the customer lives. Customers may have accounts and can take out loans. A customer may be associated with a particular banker; who may act as a loan officer or personal banker for that customer.
   - The bank offers two types of accounts: savings and checking accounts. Accounts can be held by more than one customer, and a customer can have more than one account. Each account is assigned a unique account number. The bank maintains a record of each account's balance and the most recent date on which the account was accessed by each customer holding the account. In addition each savings account has an interest rate, and overdrafts are recorded for each checking account.
   - The bank provides its customers with loans. A loan originates at a particular branch and can be held by one or more customers. A loan is identified by unique loan number. For each loan, the bank keeps track of loan amount and the loan payments. Although a loan-payment number does not uniquely identify a particular payment among those for all the bank's loans, a payment number does identify a particular payment for a specific loan. The date and the amount are recorded for each payment.
   - Bank employees are identified by their employee_id values. The bank administration stores the name and telephone number of each employee, the names of the employee's dependents, and the employee_id number of the employee's manager. The bank also keeps track of the employee's start date and, thus, length of employment.

b. Map the above ER diagram into a relational database schema, mentioning all steps that you have followed.

c. Suppose that every customer must have at least one account but is restricted to at most two loans at a time, and that a bank branch cannot have more than 1000 loans. How to represent this constraint in the above ER diagram?

d. Write relational-algebra queries to find the accounts held by more than two customers in the following ways:
   - Using an aggregate function.
   - Without using any aggregate functions.

(2) A company obtains parts from a number of suppliers. Each supplier is located in one city. A city can have more than one supplier located there and each city has a status code associated with it. Each supplier may provide many parts. The company creates a simple relational table to store this information that can be expressed in relational notation as:

FIRST (s#, status, city, p#, qty)

where

s#	supplier identifcation number
status	status code assigned to city
city	name of city where supplier is located
p#	part number of part supplied
qty	quantity of parts supplied to date

Given the following set of FDs:

s# —> city, status
city —> status
(s#,p#) —> qty

a. Identify all candidate keys of the relation. **(3 Points)**
b. Is FIRST a good relational schema? Justify your answer. **(3 points)**
c. Decompose the relation FIRST into 2NF, then into 3NF and finally into BCNF. **(3*4=12 points)**
d. Check whether the decompositions in 3NF and BCNF satisfy (i) lossless join property and (ii) dependency preservation property? **(2*5= 10 points)**