DATABASE SYSTEMS        FINAL EXAM        <u>SUBJECTIVE PART</u>

[Spring 2014]                [Total Points: 80]                [Time: 150 min.]

**NOTE:** No calculators are permitted. Please write your solutions in the spaces provided on the exam. You may use the blank areas and backs of the exam pages for scratch work. Please do not use any additional scratch paper. Write your roll no in the upper right corner of every page.

**Question 1**                    **(5points)**

State whether each of the following implications is true or false. If it is false, give a relation withonly two tuples that satisfies the functional dependencies in the left-hand side of the implicationbut does not satisfy the dependencies in the right-hand side. If it is true, show which inferencerules you used to prove it is true.

**a)** $C{\rightarrow}A$ and $CA{\rightarrow}B \models C{\rightarrow}B$

**b)** $X{\rightarrow}Z$ and $Y{\rightarrow}Z \models X{\rightarrow}Y$

**Question 2**                    **(5 points)**

Consider the relation R ($A, B, C$ ), with a set of fd's{A□ C, C □A }. List all possible keys of this relation. Prove it.

**Question 3**          **(5 points)**

Consider the relation R ($A, B, C, D, E$), with a set of fd's{AB $\rightarrow$ C, C $\rightarrow$ D, D $\rightarrow$ B, D $\rightarrow$ E }. The possible keys are {A$B$}, {AC}, and {A$D$}.

**a)** Based on the given keys, Identify the best normal form that R satisfies (1NF, 2NF, 3NF, or BCNF). Justify your answer.

**b)** Apply normalization until you cannot decompose the relations further. State the reasons behind each decomposition. Show each step of the decomposition process

**Question 4**          **(5 points)**

Find a minimal cover $F'$for the set of fd's$F = \{AB\rightarrow C, DEG\rightarrow H, A\rightarrow C, DE\rightarrow G \}$.

**Question 5**               **(20 points)**
Consider the following banking enterprise relational schema:

*Branch* (*branch-name*, *branch-city, assets*)
*Customer* (SSN, *customer-name, customer-city*)
*Loan* (*loan-number*, *branch-name, amount*)
*Borrower* (*SSN, loan-number*)
*Account* (*account-number*, *branch-name, balance*)
*Depositor* (*SSN, account-number*)

Write **Relational Algebra and SQL statements** for the following queries:

   **a)** Find the names of all branches with customers who have an account in the bank and who live in Karachi.
   **b)** Find all customers who have an account at *all* the branches located in Lahore.
   **c)** Find the accounts that have more than one account holders (joint-accounts).
   **d)** Find the names of all customers who do not have account in the branch named Faisal-Town.

**Question 6        (5 points)**

Create a view consisting of branch name and the names of customers who have either an account or a loan at that branch and name it *all-customer*.

Using the view *all-customer*, find all customers of the Garden-Town branch

**Question 7**           **(10 points)**

Consider the relational state of the banking enterprise scheme.

*Branch*

| branch-name | branch-city | assets |
|---|---|---|
| Faisal Town | Lahore | 1000000 |
| Garden Town | Lahore | 2000000 |
| All-shah | Islamabad | 5000000 |
| Defense | Karachi | 12000000 |

*Customer*

| SSN | customer-name | customer-city |
|---|---|---|
| 111 | Ali Mustafa | Lahore |
| 222 | Nida Shaheed | Gujrat |
| 333 | Aliya Shah | Lahore |
| 444 | Ahmed Noor | Islamabad |
| 555 | FahadYahya | Karachi |
| 666 | Usman Shan | Karachi |
| 777 | Haider Ali | Lahore |

*Loan*

| loan-number | branch-name | amount |
|---|---|---|
| L-101 | Faisal-Town | 10000 |
| L-102 | Garden-Town | 25000 |
| L-103 | Al-shah | 50000 |
| L-104 | Al-shah | 10000 |

*Account*

| account-number | branch-name | balance |
|---|---|---|
| A-101 | Faisal-Town | 1000 |
| A-102 | Garden-Town | 250 |

| | | |
|---|---|---|
| A-201 | Al-shah | 500 |
| A-215 | Defense | 820 |
| A-217 | Faisal Town | 9000 |
| A-222 | Garden Town | 5470 |

*Borrower*

| SSN | loan-number |
|---|---|
| 111 | L-101 |
| 555 | L-102 |
| 333 | L-104 |
| 111 | L-103 |
| 222 | L-101 |

*Depositor*

| SSN | account-number |
|---|---|
| 111 | A-101 |
| 222 | A-102 |
| 777 | A-201 |
| 444 | A-215 |
| 111 | A-222 |
| 666 | A-217 |
| 222 | A-215 |
| 111 | A-102 |

Given the above relational state, write the result of the following Queries. Also show the result of intermediate relations and describe in a sentence what each query does.

a)  **select distinct** *customer-name*
    **from** *borrower*
    **where** *customer-name* **not in** (**select** *customer-name* **from** *depositor*)

**b)**

    **select** *branch-name*
    **from** *account*
    **group by** *branch-name*
    **having** **avg**(*balance*) >= **all** (**select avg**(*balance*) **from** *account* **group by** *branch-name*)

**Question 8**          **(15 points)**

The company you work for wants to digitize their time cards. You have been asked to design the database for submitting and approving time cards. Draw the database ER diagram with the following information:

- A timecard should have hours worked and date submitted

- Each timecard is associated with exactly one employee. An employee can be permanent or employed on hourly basis.

- Each timecard should have a unique id

- Each timecard has a status: it is either approved, not approved, or pending

- Each employee has a unique id, name and address.

- Each employee submits a time card every pay period. i.e. In 1 year, they will submit multiple time cards

- Each employee either has direct deposit or physical check as their method of payment

- Each employee is associated with exactly one manager

- Each manager has a unique id and a name

- Each manager is in charge of multiple employees

- Each manager approves time cards for multiple employees

Make sure that you indicate all cardinality constraints and your model should not contain redundant entity sets, relationships, or attributes. If you need to make any assumptions, include them in your answer.

# Question 9 (5 points)

Map conceptual schema given below to a set of relations. Choose the best mapping option and specify all the mapping steps. Also shows keys and all possible constraints
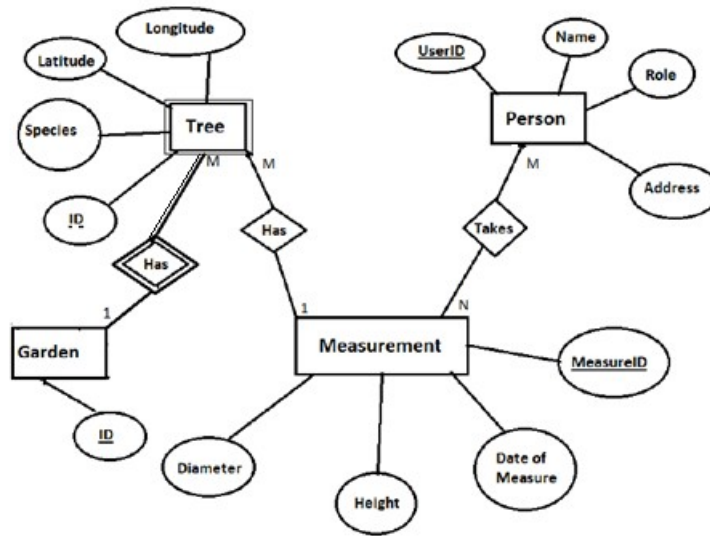
**Question 10** ( 5 points)

Answer the following questions based on the ER Diagram in Question 9:

a) Could the "Date of Measure" attribute of the *Measurement* entity be the key for the entity, instead of the "MeasureID"? Why or Why Not?

b) We want to add a "Tools Used" attribute, which will store the tool(s) used to make measurements, but are not sure where this attribute belongs. We do know that one person might use multiple tools for different trees, and also that more than one tool may be used to measure the same tree (for example, different tools may be necessary to measure the same tree in the summer, than in the winter.) Where could we add this attribute? Choose *one or more* answers from the 3 entities and 2 relationships (we would add the attribute only once, but if you believe there are multiple possible places to add the attribute, we ask you to identify all potential candidates):

   a. the entity Person
   b. the relationship Has
   c. the entity Measurement
   d. the relationship Takes
   e. the entity Tree

c) There are two roles that people can have, a Ranger and a Volunteer. Using what you know of subclassing, add these as two new entities in the ER Diagram. Add a reasonable attribute to each of the new entities. Just redraw the relevant part of the diagram that needs to change. Can we eliminate the **role** attribute from *Person*?