SECTION: _____ ROLL NUMBER: _____ NAME: _____

DATABASE SYSTEMS FINAL EXAM SUBJECTIVE PART

[Fall 2012] [Total Points: 70] [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 (5 points)

Consider a relation R(A, B, C, D, E, F, G, H, I, J), with FD's B → E, E → FH, BCD → G, CD → A, A → J, I → BCDE, H → I. The possible keys are {B}, {E}, {H}, {I}. Is this relation in BCNF? (use general definition of normal forms.) If your answer is yes, explain why. If your answer is no, decompose the relation into BCNF. State the reasons behind each decomposition and show your decomposition steps. Also specify final set of normalized relation schemas clearly.

Question 2 **(4+3+3= 10 points)**

Consider a relation R(A, B, C, D, E), with FD's AB → C, C → D, D → B, D → E.

a) Find the closures of D and AB.

b) Find all the keys for this relation. (you don't need to list superkeys that are not keys.)

c) Is this relation in BCNF? (use general definition of normal forms.) If your answer is yes, explain why. If your answer is no, decompose the relation into BCNF. Show your decomposition steps and also final set of normalized relation schemas.

Question 3 **(5 points)**

Consider the two sets of FDs: F = {A → B, A → C} and G = {A → B, B → C}. Check whether they are equivalent. Justify your answer.

Question 4 **(6+6+4+4= 20 points)**

Consider the following relational schema:

Users(<u>userid</u>, popularity, name) Sites(<u>siteid</u>, sitename, userid, viewcount) Entries(<u>entryid</u>, siteid, rating, message, createdtime, tag)

a) Write Relational Algebra and SQL statements to find all of the sitenames of Sites that have zero entries (no entries).

b) Write Relational Algebra and SQL statements to find all of the sitenames of Sites that have entries with a tag equal to "SQL Server" or NULL, but not any other tag values.

c) Write SQL statement to create the Entries table for the relational schema. Also specify PK constraint on entryid column, FK constraint on siteid column and CHECK constraint on rating column that ensures that rating is between 0 and 5 inclusively.

d) Define a view ActiveUsers that gives users with more than 5 sites. Your view must include the same attributes as the 'Users' table (userid, popularity, name).

Question 5 **(5 points)**

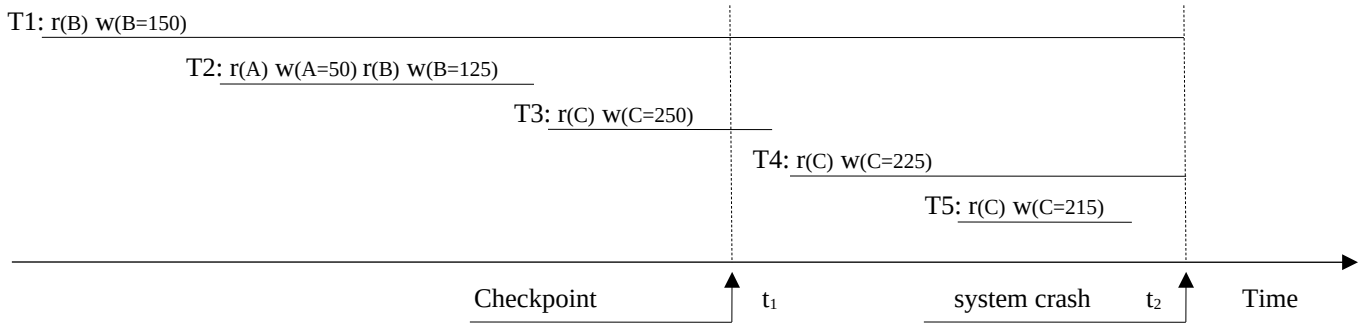
Consider the following schedule of four transactions T1, T2, T3, and T4.
S: r1(A); w1(A); r2(A); r2(B); w3(B); w2(C); r4(A); r4(B); r4(C); r2(D); r3(E).

Draw the serializability (precedence) graph for this schedule. State whether this schedule is (conflict) serializable or not. If the schedule is serializable, write down the equivalent serial schedule(s) otherwise explain why it is not.

Question 6 (5 points)

[FOR Section A & B Only]

Assume that the initial values of items are A=100, B=200, C=300. Given the following log of a recovery manager performing **deferred update**. Identify which (if any) transactions need undo and which transactions need redo operation(s)? Write down the values of items A, B, and C after system recovery.



[FOR Section C Only]

Determine whether the following schedule S is strict, cascadeless, recoverable, or nonrecoverable. Determine the strictest recoverability condition that the schedule satisfies and *also justify your answer*.

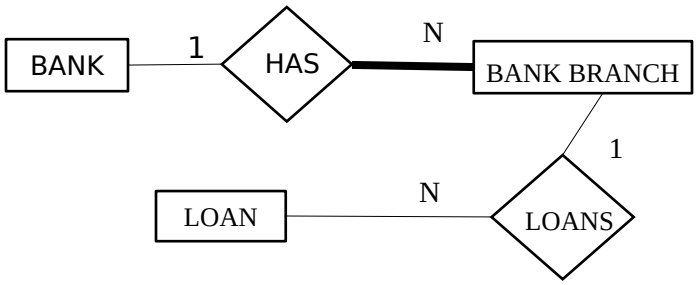
S: *r*1(A); *r*2(C); *r*3(*A*); *r*1(*C*); *r*2(*B*); *r*3(*B*); *w*1(*A*); *c*1; *w*2(*C*); *w*3(*B*); *w*2(*B*); *c*3; *c*2;

Question 7 **(3+4+3= 10 points)**

Consider the following ER models against each of the given statement. You job is to identify issues (if any) in each ER model and provide the correct ER model. *Do not worry about attributes. Do not use (min, max) notation to specify structural constraints.*

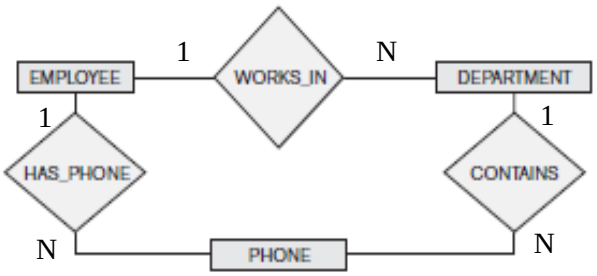
a) A bank has one or more branches. Each branch offers multiple Loans. A loan belongs to exactly one bank branch.

Insert correct diagram here:



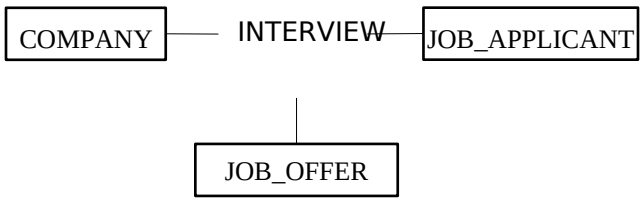
b) An employee can work in multiple departments (at least 2 and at most 4 departments). Each department must have one and may have up to three phone numbers. A phone number belongs to only one department. An employee can be reached at all the phone number of each department he works in.

Insert correct diagram here:



c) A company calls many applicants to fill some of its vacant seats (jobs). However, some interviews results in the job offer while others do not.

Insert correct diagram here:



Question 8 (10 points)

A local transportation authority in Lahore wants to implement a database to keep statistics on public transportation (buses), with emphasis on keeping track of delays and the number of travelers. Draw an ER diagram corresponding to incorporate the following information:

• Information on buses: This includes bus identification number, type, capacity, and production year. In addition to this the range of each bus (the number of kilometers it will drive on a full tank) should be recorded. The type of bus refers to the manufacturer's code for a specific kind of buses. All buses with the same code are identical.

• Information on bus drivers: You need to record each driver personal identification number, his hired date, the bus he words on and his salary. A bus driver does not drive a specific bus, but may drive any bus.

• Route information: The sequence of stops on each bus route. Each route has a unique route number.

• Vehicle usage: For each route and departure time, on each day, record which bus was used. (Note only a single bus is used for particular route and departure time –several buses can't be coupled together.)

• Timetable information: Information on planned arrival and departure times for each route and every stop.

• Timetable statistics: Information on actual arrival and departure times for every bus and every stop, on every day.

• Traveler statistics: Periodically, surveys are being made that record the destinations of all travelers in a given bus at a given time (between two stops).

• Manning: Who has worked on a particular vehicle at every time? It should be taken into account that manning may change at any time during a route.

Suppose that we desire the database to evolve over time (e.g. with new time tables), but we also want to be able to store and query historical data. Outline how your ER diagram could be changed to achieve this.