香 港 中 文 大 學
The Chinese University of Hong Kong

Course Examination 1st Term, 2012-13

Course Code & Title : BMEG 3120 Database and Security for Biomedical Engineering

Time Allowed : 2 hours

Student ID : ..... Seat No. : .....

Problem 1 ($5\% \times 6 = 30\%$). Consider the following relations about NBA:

- PLAYER(pid, pname, nation). Each tuple describes a player with *pid* being the player's id, *pname* his name, and *nation* his nationality. The table has a candidate key pid.
- TEAM(tid, tname). Each tuple describes a team with *tid* being the team's id, and *tname* its name. The table has a candidate key tid.
- REGISTER(pid, tid, salary, year). Each tuple records the fact that a certain player (indicated by *pid*) played for a certain team (indicated by *tid*) in a specific *year* with an annual income given in *salary*. The table has a candidate key (pid, year). Note that a player may belong to various teams in different years.

Write relational algebra queries for the following tasks.

(a) Find the names of all teams that "Michael Jordan" ever played for.
(b) Find the names of all players of the team "Heat" in 2012.
(c) Find the names of all players that were teammates of "Michael Jordan" (i.e., such a player played in the same team as Michael in some year).
(d) For each country, define its *debut year* as the first year in which a player of the country was registered in any team. Find the debut year of China.
(e) We say that a player p *supersedes* "Michael Jordan" if p played in all the years in which Michael played. Find the names of all such players p.

Problem 2 ($5\% \times 6 = 30\%$). Consider the same relations as in Problem 1. Write SQL statements for the following tasks.

(a) Find the names of all players from "China".
(b) For each player, display his pid, and the first and last years in which he played.
(c) Find the pids of all players that played from 1996 through 2005 (i.e., such a player played in 1996, 1997, ..., and 2005).
(d) Find the year(s) in which at least 10 players' (annual) salaries were over 20,000,000.
(e) Define the *wealth* of a player as the total amount of salary he drew in his whole career. Also, define his *lifetime* as the number of years in which he played (note that the years in which he played may not be continuous due to injury). Given two players p_1, p_2, we say that p_1 *dominates* p_2 if p_1 has higher wealth but shorter lifetime than p_2. Find the pids of all such players p that p is not dominated by any other player.

Problem 3 (5%). Consider the following SQL statement on the relations in Problem 1. Explain in English the output of the statement.

```
select pid from REGISTER
where salary > all (
    select sum(salary) from REGISTER R, PLAYER P
    where R.pid = P.pid and P.nation = "Japan"
    group by R.pid)
```

Problem 4 ($2\% \times 3 = 6\%$). Consider relation SUPERVISE(profId, stuId, projId) where each tuple records the fact that a student (indicated by *stuId*) participates in a project (indicated by *projId*) that is supervised by a professor (indicated by *profId*). Write functional dependencies to enforce the following constraints, respectively.

(a) Every professor can supervise at most one student.
(b) No student can participate in more than one project.
(c) No project can be supervised by more than one professor.

Problem 5 (29%). Consider a relation $R(A, B, C, D, E)$ on which we have collected a set of functional dependencies:

$$\begin{aligned} A &\rightarrow BD \\ AC &\rightarrow E \\ D &\rightarrow A \end{aligned}$$

(a) (5%) What is the closure of AD?
(b) (5%) Derive $CD \rightarrow E$ using only Armstrong's Axioms (i.e., reflexivity, transitivity, and augmentation).
(c) (3%) Find all the candidate key(s) of R.
(d) (3%) Is R in 3NF? Why?
(e) (3%) Is the decomposition of R into $R_1(A, B, C, D)$ and $R_2(C, E)$ lossless? Why?
(f) (10%) Decompose R into BCNF tables. Please also point out the candidate key(s) of the final tables produced by your decomposition.

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