

## CS430/630 – Final Exam Practice

40 points, 150 minutes

For questions 1-3, you are given the following schema:

```
Students (sid:integer, sname:string, age:integer)
Courses (cid:integer, cname:string, credits:integer)
Grades (sid:integer, cid:integer, grade:string)
```

The meaning of attributes is as follows:

- sid: unique student identifier, primary key in table Students
- cid: unique course identifier, primary key in table Courses
- sname: student name
- age: student age
- cname: course name
- credits: number of credits for a course
- grade: the grade obtained by student identified by sid for course identified by cid; sid and cid are foreign keys referring to the sid and cid fields in the Students and Courses tables, respectively.

### Question 1

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Write **relational algebra** expressions for the following queries given the schema above:

- Find the grades that students of age 20 obtained in courses with 4 credits.
- Find the names of students who took a course named 'Calculus' and did not get a 'C' grade in any course.
- Find the ages of students who got an 'A' in some course with 3 credits or who got a 'B' in any course.
- Find the maximum age among students who took 'Calculus'.

Note: for Q1, you are NOT ALLOWED to use SQL, answers in SQL will not receive any marks. Derive relational algebra expressions only.

### Question 2

Write **SQL queries** for the following:

- Find distinct ages of students who took a course with name 'CS310'.
- Find the names of students who took only 4-credits courses.
- Find the average grade over all students for those courses which enrolled at least 10 students with age greater or equal than 25.
- Find the names of students who took every 4-credits course.
- Find for each course identifier (cid) the sid(s) of the student(s) who got the highest score.

### Question 3

Using the schema above, and assuming that grade is of type integer, provide the SQL statement to create a view `TopStudents` that lists the student ID, name and average grade (GPA) for students that have GPA above 3.0.

### Question 4

Design a database for a bank, including information about customers and their accounts. Information about customers includes their name, address, phone and SSN. Accounts have numbers, types (e.g., savings/checking) and balances. Also record the customer(s) who own an account.

- Draw the E/R diagram for this database, assuming no constraints hold other than what results from the schema.
- Modify the E/R diagram from (a) to reflect the constraint that each customer must have at least one account.
- Modify the E/R diagram from (a) to reflect the constraint that an account must have only one customer.
- Modify the diagram from (a) such that a customer can have a set of addresses (which are street-city-state-zip) and a set of phones. Recall that in the E/R model there can be only primitive data types (no sets).

### Question 5

Suppose you are given a relation  $R$  with four attributes  $ABCD$  and the following set of FDs:  $AB \rightarrow C$ ,  $BC \rightarrow D$ .

- Identify the candidate key(s) for  $R$ .
- Determine if  $R$  is in BCNF, 3NF, or none of the above. If it is not in BCNF, decompose it into a set of BCNF relations.

### Question 6

Show the grant diagrams after steps 4 and 5 of the sequence of actions below, where  $A$  owns the relation on which the privilege  $p$  is assigned. Can  $C$  still exercise privilege  $p$ ? What about  $E$ ?

Step	Executed by	Action
1	A	GRANT $p$ TO $B$ WITH GRANT OPTION
2	A	GRANT $p$ TO $C$
3	B	GRANT $p$ TO $D$ WITH GRANT OPTION
4	D	GRANT $p$ TO $E$
5	B	REVOKE $p$ FROM $D$ CASCADE