

Name: \_\_\_\_\_

1. (1 pt.)

- **Read all material carefully.**
- You may refer to your books, papers, and notes during this test.
- No computer or network access of any kind is allowed (or needed).
- Write, and draw, carefully. Ambiguous or cryptic answers receive zero credit.
- Use textbook and classroom conventions for notation, algorithmic options, etc.
- Ask for clarifications on the above if needed.
- The question marked with a ★ is
  - required for COS 580, but
  - optional (extra credit, graded more strictly than non-★) for COS 480.
- *COS 550 students (only) get 10 extra minutes.*

Write your name in the space provided above.

2. (19 pts.) Recall, from class exercises, the database composed of relations `Students(id, name, year)`, `Courses(id, title, ta)`, and `Enrolls(student, course, credits)`, with the semantics described there. We say student  $x$  has TA  $y$  if  $x$  is enrolled in a class that has  $y$  as a TA. Provide a standard SQL (as defined in the textbook) query for the list of all tuples  $(n, i, m)$  such that the student with name  $n$  and ID  $i$  has  $m$  distinct TAs. The tuples should be sorted in descending order by  $m$  and (secondary order) ascending order by  $n$ . You may use views to present your query. *Briefly explain why your query is correct.*

[additional space for answering the earlier question]

3. (20 pts.) Provide an extended bag algebra query that is equivalent to the query of Question 2. You may use all the bag operators defined in the textbook, and may use the linear notation to present your query. *Briefly explain why your query is correct.*

4. ★ (10 pts.) For the database of Question 2, provide a standard SQL query for pairs of students for who are enrolled in identical sets of classes. In more detail, if  $C_x$  and  $C_y$  denote the classes taken by students  $x$  and  $y$ , respectively, then the unordered pair (i.e., 2-element set)  $\{x, y\}$  qualifies if  $C_x = C_y$ . The output should list each such unordered pair exactly once, as either  $(x, y)$  or  $(y, x)$ , but not both. *Briefly explain why your query is correct.*

[additional space for answering the earlier question]