

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 the conventions used in class and the textbook for all material.
- COS 480 students should answer non-★ questions; ★ questions are for extra credit.
- COS 580 students should answer all questions, including ★ questions.
- *COS 550 students (only) get 10 extra minutes.*

Write your name in the space provided above.

2. (14 pts.) Consider a relation  $R(A, B, C, D, E, F)$  with the following basis of functional dependencies:

$$AB \rightarrow CE$$

$$C \rightarrow AD$$

$$BE \rightarrow CF$$

$$F \rightarrow C$$

List **all** keys of  $R$ . Justify your answer.

[additional space for answering the earlier question]

3. (15 pts.) Refer to the schema of Question 2.

- (a) Indicate which (if any) of the functional dependencies are BCNF violations.
- (b) Normalize the schema to BCNF. *Show details for all intermediate steps, such as the dependency used for decomposition, the resulting relations, and projected dependencies.*

[additional space for answering the earlier question]

4. (15 pts.) For each of the following dependencies: Indicate whether the it is *logically implied* by the dependencies listed in Question 2. If so, prove the implication. If not, provide a counterexample.

$$\begin{array}{l} BCD \xrightarrow{?} AE \\ AF \xrightarrow{?} BD \end{array}$$

5. (10 pts.) \* Consider a relational schema  $S(A, B, C, D, E)$  with the following basis of dependencies (a mix of functional and multi-valued).

$$\begin{aligned} AB &\twoheadrightarrow C \\ BC &\twoheadrightarrow AD \\ B &\rightarrow CE \\ E &\rightarrow C \end{aligned}$$

Is the dependency  $AC \twoheadrightarrow BE$  *logically implied* by the above? If so, provide a proof, else provide a counterexample.