

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.

Write your name in the space provided above.

2. (5 pts.) Consider $R(A, B, C, D, E)$ with dependencies

$$AB \rightarrow C$$

$$AC \rightarrow D$$

$$DE \rightarrow B$$

$$BE \rightarrow A$$

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

3. (10 pts.) Decompose the schema of Question 2 as necessary to generate a BCNF schema. For each decomposition used, clearly indicate:
- the dependency used for the decomposition,
 - the relations before and after the decomposition, and
 - the projected dependencies for the decomposed relations.

[additional space for answering the earlier question]

4. (7 pts.)

- (a) Provide an example of a Datalog query that is *safe, but not stratified*.
- (b) Provide an example of a Datalog query that is *stratified, but not safe*.
- (c) Explain both examples briefly, justifying the claims regarding safety and stratification.

5. (12 pts.) Consider a relation `Edges(src, dst, color)` that represents edges of a connected directed graph, with colors as edge labels: A tuple $(s, d, c) \in \mathbf{Edges}$ denotes a directed edge, with color c , from vertex s to vertex d .

Write safe, stratified Datalog queries for:

- (a) Pairs of vertices (a, b) such that there is a directed path from a to b that contains exactly one red edge.
- (b) Pairs of vertices (a, b) such that there is a directed path from a to b composed of edges with alternating red-green colors. Such a path may be of any length and may begin with either a red or a green edge.
- (c) Pairs of vertices (a, b) such that there is a directed path from a to b (composed of edges of any colors) but there is no directed path from a to b composed of only red edges.

6. (5 pts.) Prove or disprove: Every binary relation is in BCNF.