Name: _________________________________

1. (1 pt.)
   ○ **Read all material carefully.**
   ○ **If in doubt whether something is allowed, ask, don't assume.**
   ○ You may refer to your books, papers, and notes during this test.
   ○ E-books may be used **subject to the restrictions** noted in class.
   ○ Computers are not permitted, except when used strictly as ebooks.
   ○ Network access of any kind (cell, voice, text, data, ...) is not permitted.
   ○ Write, and draw, carefully. Ambiguous or cryptic answers receive zero credit.
   ○ Use class and textbook conventions for notation, algorithmic options, etc.

Write your name in the space provided above.

**WAIT UNTIL INSTRUCTED TO CONTINUE TO REMAINING QUESTIONS.**

Do not write on this page below this point.

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2. (9 pts.) Consider a relation $R(A, B, C, D, E, F, G)$ with the following basis of dependencies:

\[
\begin{align*}
AB & \rightarrow C \\
B & \rightarrow D \\
DC & \rightarrow A \\
CEF & \rightarrow AB \\
FG & \rightarrow C
\end{align*}
\]

Provide a smallest (cardinality) instance of $R$ that violates the dependency $CEF \rightarrow AB$ without violating any of the other dependencies. Briefly explain why your answer is correct (including why no smaller instance suffices).
3. (10 pts.) Indicate which of the following dependencies are *logically implied* by those in the basis of Question 2. *Justify* your answers briefly.

(a) $AF \rightarrow B$.
(b) $BCF \rightarrow A$.
(c) $EFG \rightarrow C$. 
4. (20 pts.) For the relation $R$ of Question 2 (dependencies repeated here):

- $AB \rightarrow C$
- $B \rightarrow D$
- $DC \rightarrow A$
- $CEF \rightarrow AB$
- $FG \rightarrow C$

(a) List **all** keys of $R$.

(b) Explain your answer, noting why the keys you list are valid and also why there are no other keys.

(c) How many **superkeys** does $R$ have? Explain your answer. (You need not list all superkeys.)
[additional space for answering the earlier question]
5. (20 pts.) Decompose the schema of Question 2 to BCNF. **Show all intermediate steps and details**, such as keys, projected dependencies, and decomposed relations, for each (recursive) normalization invocation.

\[
\begin{align*}
AB & \rightarrow C \\
B & \rightarrow D \\
DC & \rightarrow A \\
CEF & \rightarrow AB \\
FG & \rightarrow C
\end{align*}
\]
[additional space for answering the earlier question]
[additional space for answering the earlier question]