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.

   Write your name in the space provided above.

2. (14 pts.) Convert the following grammar to Chomsky normal form. Follow the procedure described in the textbook and **show intermediate steps.**

$$
\begin{aligned}
S &\rightarrow AB \mid ASAB \\
A &\rightarrow AA \mid aA \mid b \\
B &\rightarrow AB \mid ba
\end{aligned}
$$

3. (10 pts.) Using the tabular representation from class, depict the operation of the algorithm of Theorem 7.16 (CYK) on the normalized grammar of Question 2 and string `abababba`.

4. (10 pts.) Using the mapping from the proof of Theorem 7.32, map the following SAT instance into a CLIQUE instance.

$$(w \vee x \vee \bar{y} \vee \bar{z}) \wedge (\bar{w} \vee \bar{x} \vee \bar{y} \vee z) \wedge (w \vee x \vee \bar{y} \vee z)$$

5. (10 pts.) Is the SAT instance of Question 4 satisfiable? If so, provide values of the variables that satisfy the formula **and** depict *all the corresponding solutions* of the CLIQUE isntance. If not, explain separately why the SAT and CLIQUE instances have no solutions.