

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. (19 pts.) Convert the following grammar to Chomsky normal form. Upper-case letters denote variables and lower-case letters denote terminals. *Show enough intermediate results and include brief explanations* to make it clear that the method described in the textbook is being followed.

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

[additional space for answering the earlier question]

3. (15 pts.) Using the textbook's method, provide an *informal* and a *formal* description of a pushdown automaton that is equivalent to the grammar of Question 2.

4. (10 pts.) Provide one string that belongs to the grammar of Question 2 and a leftmost derivation that generates it.