

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.
- Write, and draw, carefully. Ambiguous or cryptic answers receive zero credit.
- Use class and textbook conventions for notation, algorithmic options, etc.
- For the duration of the exam, the only communication (live or network) should be with the instructor for clarifications, etc.
- At the end of the exam, scan your work to a PDF file named using the following template and upload it in the usual way:  
`cos451-mt02-lastname-firstname-pqrs.pdf`  
(replacing *lastname* and *firstname* with yours and *pqrs* with an arbitrary 4-digit number).

Write your name in the space provided above.

WAIT UNTIL INSTRUCTED TO CONTINUE TO REMAINING QUESTIONS.
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Do not write in the following table.

Q	Full Score
1	1
2	19
3	20
total	40

2. (19 pts.) Convert the following grammar to Chomsky normal form. Upper-case letters represent 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.

$$\begin{aligned} A &\rightarrow aa \mid ABA \\ B &\rightarrow b \mid bAbA \mid \varepsilon \end{aligned}$$

[additional space for answering the earlier question]

3. (20 pts.) Let  $G_2$  be the grammar of Question 2. For each of the following strings, indicate whether the string belongs to  $L(G_2)$ . If so, provide a leftmost derivation of that string. Otherwise, prove as precisely as possible that the string does not belong to  $L(G_2)$ .

(a) aabaabaaaa

(b) aabbaba

[additional space for answering the earlier question]