

**Please write your name and net id on all pages turned in. We need net id to record your grade.** If you turn in each problem on a separate sheet we will grade your problems in parallel and get your assignment back to you by the following Wednesday. If you turn in homework not on separate sheets we will circulate your homework and grade the problems in serial and thus it will likely be delayed somewhat in getting back to you.

Write a context-free grammar for each of the sets in 1 through 8. Do two problems per page.

1.  $\{xx^Rww^R \mid x \in \{a,b\}^*, w \in \{a,b\}^*\}$
2.  $\{a^n b^m c^{n+m} \mid n, m \geq 0\}$
3.  $\{a^i b^j \mid i = j \text{ or } i = 2j\}$
4.  $01\{0^n 10^{n+1}\}^*$
5.  $\{a^i b^j c^k d^l \mid i = k \text{ or } j = l\}$
6. The set of all strings not in  $\{wcw^R \mid w \in \{a,b\}^*\}$
7. The set of all strings not in  $\{a^n b^n c^n \mid n \geq 1\}$
8. The set of all strings not in  $\{01001000100001 \dots 10^n 1 \mid n \geq 1\}$
9. Prove or disprove that the grammar

$$S \rightarrow aSbSbS \mid baSbS \mid bbSaS \mid \varepsilon$$

generates the language consisting of all strings with twice as many b's as a's.