

**Theory of Computation (CSC 339) – Fall 2023**

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<b>Tutorial 5: Context-free Languages and Grammars</b>
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1. Give a CFG for the following language:  
Determining if a string is an integer in the following format: An optional minus sign followed by at least one digit.
2. Give a CFG for the following language:  
Strings in the following format: An optional minus sign followed by at least one digit or an optional minus sign followed by any number of digits, a decimal point, and at least one digit.
3. Give a CFG for the language of properly nested strings of parentheses, square brackets ([ ]), and braces ({}).
4. Give CFG's for the following languages;
  - (a) The language of strings that contain the substring 001.
  - (b) The language of strings that start and end with the same symbol.
  - (c)  $\{1^i \# 1^j \# 1^{i+j}\}$ . The alphabet is  $\Sigma = \{1, \#\}$ .
  - (d)  $\{0^n 10^n | n \geq 0\}$ . The alphabet is  $\Sigma = \{0, 1\}$ .
  - (e)  $\{0^i 1^j | i \leq j\}$ . The alphabet is  $\Sigma = \{0, 1\}$ .
5. Give CFGs that generate the following languages.  $\Sigma = \{0, 1\}$ 
  - (a)  $\{w | w \text{ contains at least three 1's}\}$ .
  - (b)  $\{w | \text{the length of } w \text{ is odd and its middle symbol is 0}\}$ .