Due: March 8

1. Give PDAs that recognize the following languages:
   (a) \{a^n b^m c^n d^m | n, m \geq 0\}.
   (b) \{x_1 \# x_2 \# x_3 | x_1, x_2, x_3 \in \{a, b\}^* \text{ and either } x_2 = x_1^R \text{ or } x_2 = x_3^R\}.

2. Let \(G\) be the grammar
   \[
   \begin{align*}
   S & \rightarrow V aT \\
   T & \rightarrow \varepsilon aUbT | bV aT \\
   U & \rightarrow \varepsilon aUbU \\
   V & \rightarrow \varepsilon bV aV
   \end{align*}
   \]
   (a) Using the method from class, give a PDA \(M\) with \(L(M) = L(G)\).
   (b) Show an accepting computation for \(M\) on the string \(bbabaaaba\) by giving a chart with the state, tape contents, and stack contents after each step.

3. Read Definition 2.8, Theorem 2.9 and Example 2.10 in the textbook (third edition) concerning Chomsky Normal Form and then put the grammar in Problem 2 into Chomsky Normal Form.