This homework is to be submitted at the beginning of class.

On homework, you may discuss with other students in the course about how to solve a problem, but the write-up should be your own. You must include the names of any students you consulted with. Give credit where credit is due. You may use JFLAP to check your answers for this assignment, but it must be written up and turned in.

1. (5 pts) For the following CFG, remove the \( \lambda \)-productions. Show the resulting grammar.

   \[
   S \rightarrow AaB \\
   A \rightarrow SCD | a \\
   B \rightarrow bB | CD \\
   C \rightarrow \lambda \\
   D \rightarrow dD | \lambda
   \]

2. (5 pts) For the following CFG, remove the unit-productions. Show the resulting grammar.

   \[
   S \rightarrow abS | A \\
   A \rightarrow aA | B | C \\
   B \rightarrow baB | D \\
   C \rightarrow c \\
   D \rightarrow d
   \]

3. (5 pts) For the following CFG, remove the useless productions. Show the resulting grammar.

   \[
   S \rightarrow aA | bEc \\
   A \rightarrow aB | aaA \\
   B \rightarrow ASa \\
   C \rightarrow cDE | c \\
   D \rightarrow SaC | aC \\
   E \rightarrow eE | e
   \]

4. (5 pts) For the following CFG, convert the grammar to CNF. This grammar does not have any \( \lambda \)-productions, unit-productions or useless productions.
S \rightarrow SS \mid aAbB \\
A \rightarrow a \\
B \rightarrow bB \mid b \\

5. (5 pts) For the following CFG, convert the grammar to CNF. This grammar may have \( \lambda \)-productions, unit-productions or useless productions.

\[
S \rightarrow ACa \\
A \rightarrow B \mid aSa \\
B \rightarrow b \mid c \\
C \rightarrow \lambda
\]