1. For the following languages, give a CFG that generates it.

(a) \{ w \in \{0,1\}^* \mid w \text{ contains twice as many 1's as 0's} \}

(b) the set of regular expressions over \{ a, b \}, using the alphabet \{ a, b, \cup, \ast, \circ, (, ), \epsilon, \phi \}. (Use Definition 1.26 on p. 64 of our text)

(c) the set of strings described by the regular expression \((01^*) \cup (10)^*\).

2. Describe a PDA that accepts \{ a^n b^m c^q \mid n, m, q \geq 0 \text{ and } q \neq n + m \}.

3. Problem 2.2 in text.

4. Show the steps to putting the following grammar in Chomsky normal form: (Here, the terminals of the grammar are \{ +, *, (, ), a \})

\[
\begin{align*}
E & \rightarrow E + T \mid T \\
T & \rightarrow T \ast F \mid F \\
F & \rightarrow (E) \mid a
\end{align*}
\]

5. Consider the grammar over the alphabet \{ sub, sup, c, (, ) \}

\[
\begin{align*}
E & \rightarrow E_{sub} E_{sup} E \mid E_{sub} E \mid E_{sup} E \\
E & \rightarrow (E) \mid c
\end{align*}
\]

Is the grammar ambiguous? Support your answer.

6. Show the following language is not context-free:

\{ www \mid w \text{ is in } \{ a, b \}^* \}