1. Do Problem 9, Section 6.1 of the text.

2. Construct a grammar in Chomsky Normal Form that generates $L(M)$ where $M$ is the NFA $M = (\{q_1, q_2, q_3, q_4\}, \{a, b\}, \delta, q_1, \{q_4\})$ and $\delta$ is given by

\[
\begin{array}{|c|c|c|c|}
\hline
\delta & a & b & \lambda \\
\hline
q_1 & \{q_2\} & \{q_1\} & \phi \\
q_2 & \phi & \{q_2\} & \{q_3\} \\
q_3 & \{q_1\} & \phi & \{q_4\} \\
q_4 & \{q_2\} & \{q_4\} & \phi \\
\hline
\end{array}
\]

3. Consider the grammar $G$ whose productions are

\[
S \rightarrow XZ | ZY \\
X \rightarrow ZX | a \\
Y \rightarrow XZ | a \\
Z \rightarrow YY | b
\]

(a) Use the CYK algorithm (not an algorithm of your own) to show that $bababa \in L(G)$.

(b) Use part (a) to construct a derivation tree for $bababa$.

4. Let $\Sigma = \{a, b\}$ and $c \notin \Sigma$. Define

$\mathcal{L}_1 = \{uvc \mid u, v \in \Sigma^+, |u| = |v|\}$, $\mathcal{L}_2 = \{uvc \mid u, v \in \Sigma^+\}$, $\mathcal{L}_3 = \{ucvR \mid u \in \Sigma^+\}$.

For each $\mathcal{L}_i$, $i = 1, 2, 3$, either construct a CFG $G_i$ with $\mathcal{L}_i = \mathcal{L}(G_i)$ or prove that $\mathcal{L}_i$ is not a CFL.

5. Consider the language $\mathcal{L} = \{ww \mid w \in \{a, b\}^*\}$. Is $\mathcal{L}$ context-free? Either construct a CFG for it, or prove that it is not a CFL.

6. Do Problem 11 from Section 6.2 of the text. The relevant material on the Greibach Normal Form is on pp. 174-176 of the textbook.
7. Determine the languages generated by the following two grammars in Greibach Normal Form:

\[
\begin{align*}
S & \rightarrow aSB \mid aB \\
B & \rightarrow b
\end{align*}
\]

\[
\begin{align*}
S & \rightarrow aSA \mid bSB \mid a \mid b \\
A & \rightarrow a \\
B & \rightarrow b
\end{align*}
\]

8. Suppose \( G \) is a CFG and \( w \in \mathcal{L}(G) \) with \( w \neq \lambda \). How long is a derivation of \( w \) in \( G \) in terms of \( |w| \) if

(a) \( G \) is in Chomsky normal form,

(b) \( G \) is in Greibach normal form.

Prove your answers.