1. (20+10 points) Consider the grammar $G$ from Example 4.5.2:

$$
S \rightarrow AT \mid AB \\
T \rightarrow XB \\
X \rightarrow AT \mid AB \\
A \rightarrow a \\
B \rightarrow b
$$

(a) Give the upper diagonal matrix produced by the CYK algorithm when run with $G$ and the input string $abbb$. Show all your work.

(b) Is $abbb \in L(G)$? Why? Provide the reason based on the upper diagonal matrix you constructed.

2. (20+10+10 points) Consider the following grammar $G$. Note that $G$ was obtained by transforming the grammar $S \rightarrow aSa \mid bSb \mid a \mid b \mid \lambda$ to Chomsky Normal Form.

$$
S \rightarrow AR \mid BX \mid AA \mid BB \mid a \mid b \mid \lambda \\
T \rightarrow AR \mid BX \mid AA \mid BB \mid a \mid b \\
R \rightarrow TA \\
X \rightarrow TB \\
A \rightarrow a \\
B \rightarrow b
$$

(a) Give the upper diagonal matrix produced by the CYK algorithm when run with $G$ and the input string $abba$. Show all your work.

(b) Is $abba \in L(G)$? Why? Provide the reason based on the upper diagonal matrix you constructed.

(c) Is $abb \in L(G)$? Why? Provide the reason based on the upper diagonal matrix you constructed.

3. (30 points) Let $M$ be the PDA in Example 7.1.3 on page 226. $M$ accepts even length palindromes. Show the computation trees for the strings $aabbbaa$ and $aba$. 

![Computation trees](attachment:computation_trees.jpg)