1 Context-Sensitive Grammars (4 Points)

We discussed two different definitions for context-sensitive grammars in class:

Let $G = \{V, \Sigma, S, P\}$ be a grammar.

**Definition 1.1** If each production $\alpha \to \beta$ in $P$ satisfies $|\alpha| \leq |\beta|$, then the grammar $G$ is a Type 1 or context-sensitive grammar.

**Definition 1.2** If all productions in $P$ are of the form

$$\alpha A \gamma \to \alpha \beta \gamma \quad \text{with } \alpha, \gamma \in (\Sigma \cup V)^*, \beta \in (\Sigma \cup V)^+, A \in V,$$

then the grammar $G$ is a Type 1 or context-sensitive grammar.

Show that Definition 1.2 implies Definition 1.1.
2 LL(1) Parsing (6 Points)

Consider the grammar \( G = (V, \Sigma, S, P) \) with \( V = \{S, B, P, L, R\} \) and \( \Sigma = \{x, (, ), \{, \}, \}, \} \) and \( S \) as the start symbol, where \( P \) is the set of productions:

\[
\begin{align*}
S & \rightarrow B \\
B & \rightarrow \{L\} \\
P & \rightarrow (L) \\
L & \rightarrow SR \\
L & \rightarrow xR \\
R & \rightarrow ,L \\
R & \rightarrow \epsilon \\
\end{align*}
\]

a) Calculate the First set for \( V \).

b) Calculate the Follow set for \( V \).

c) Write down the LL(1) parsing table for \( G \).

d) Generate the parse tree for the string \( \{x, (x, x), x\} \).