Part 1 --- Ambiguous Grammars

Consider the following ambiguous grammar.

Example 1)

\[ E \rightarrow E + E \]  
\[ E \rightarrow E \ast E \]  
\[ E \rightarrow - E \]  
\[ E \rightarrow i \]

Problem 1) Prove that this grammar is ambiguous by giving an input with two parse trees.

Problem 2) The instructor will give you a version of this grammar that is not ambiguous. We will let \( \ast \) and \( + \) have their usual precedences, and associate to the left. Unary minus binds most tightly. Show that your input has only one parse tree now.

\[ E \rightarrow E + F | F \]  
\[ F \rightarrow F \ast U | U \]  
\[ U \rightarrow - U | i \]

Problem 3) Stratification removed the ambiguities. How did it do that?
Here is a new grammar for you.

\[
E \rightarrow E \ a \ E \\
| \ E \ b \ E \\
| \ E \ x \ E \\
| \ E \ y \ E \\
| \ i
\]

**Problem 4)** Prove that this grammar is ambiguous by giving an input that has two parse trees.

**Problem 5)** Stratify the grammar to remove ambiguity. Let \( a \) have highest precedence, associating to the left. Next is \( b \), associating to the left. Then we have \( y \) associating to the right. Let \( x \) have the lowest precedence, and associate to the right. Show that your sentence has only one parse tree.
Part 2 --- First and Follow Sets

Calculate the first and follow sets for these grammars.

**Example 2)**

\[
S \rightarrow aE b \\
\mid x \\
E \rightarrow xy \\
\mid \epsilon
\]

**Problem 6)**

\[
S \rightarrow aE F b \\
\mid xEF \\
E \rightarrow xy \\
\mid \epsilon \\
F \rightarrow Ezq \\
\mid wS
\]

**Problem 7)**

\[
S \rightarrow aF E b \\
\mid xFE \\
E \rightarrow xy \\
\mid \epsilon \\
F \rightarrow Ezq \\
\mid wS
\]
Ambiguous Grammars / First and Follow Sets --- Team's Assessment (SII)

Manager or Reflector: Consider the objectives of this activity and your team's experience with it, and then answer the following questions after consulting with your team.

1. **What was a strength of this activity?** List one aspect that helped it achieve its purpose.

2. **What is one thing we could do to improve this activity to make it more effective?**

3. **What insights did you have about the activity, either the content or at the meta level?**