Name: _____

Solutions

1. (1 pt.)
   - **Read all material carefully.**
   - *If in doubt whether something is allowed, ask, don't assume.*
   - You may refer to your books, papers, and notes during this test.
   - E-books may be used.
   - Computers are permitted but discouraged.
   - **Electronic and network resources must only be used as a passive library.**
   - Write, and draw, carefully. Ambiguous or cryptic answers receive zero credit.
   - Use class and textbook conventions for notation, algorithmic options, etc.

   Write your name in the space provided above.
   Do not write anything else on this page.

2. (9 pts.) Answer the following briefly, **in the context of the *PLY* system as discussed in class**.

   (a) What is the main difference between literal and non-literal tokens? Ⓐ *Non-literal tokens may have data associated with them, such as the actual number for a token representing numbers. Literal tokens have no such data. Literal tokens are also limited to just one character.*

   (b) Provide a code snippet that defines the literal tokens `+` and `*`. Ⓐ `literals = ['+', '-']`

   (c) Provide a code snippet that defines the non-literal tokens `node` and `edge`. Ⓐ `tokens = ( 'node', 'edge', )`

3. (10 pts.) Consider the following context-free grammar.

$$
\begin{aligned}
S &\rightarrow B\ F\ F \\
B &\rightarrow \texttt{e} \mid B\ \texttt{e}\ S\ \texttt{e} \\
F &\rightarrow \texttt{n} \mid \texttt{n}\ B
\end{aligned}
$$

   (a) For each symbol used above (S, B, F, $\rightarrow$, |, `e`, `n`), indicate whether it belongs to the *language* (defined by the grammar) or the *metalanguage* or the *meta-metalanguage*. Provide *brief* explanations **iff** (if and only if) you wish to qualify for any partial credit.

Ⓐ *Language symbols:* `e`, `n`. *Metalanguage (CFG) symbols:* S, B, F, $\Rightarrow$. *Meta-metalanguage symbols: (|). [There is some permissible variation for metalanguage v. meta-metalanguage.]*

(b) For each of the following *sentences*, state clearly whether the sentence is *valid* (belongs to the language of the grammar). If it does then provide a leftmost derivation for it; else explain (as precisely as possible) why it does not. Ignore all whitespace.

(1) `e n n e`

(2) `e n n e e e n n e`

Ⓐ *Both sentences are valid so no changes are needed. In the following derivations, the numbers in parentheses refer to the rule being used, with rules numbered sequentially from 1.*

$$\begin{aligned} \underline{S} &\overset{1}{\Rightarrow} \underline{B}FF \\ &\overset{2}{\Rightarrow} e\underline{F}F \\ &\overset{4}{\Rightarrow} en\underline{F} \\ &\overset{5}{\Rightarrow} enn\underline{B} \\ &\overset{2}{\Rightarrow} enne \end{aligned}$$

$$\begin{aligned} \underline{S} &\overset{1}{\Rightarrow} \underline{B}FF \\ &\overset{2}{\Rightarrow} e\underline{F}F \\ &\overset{4}{\Rightarrow} en\underline{F} \\ &\overset{5}{\Rightarrow} enn\underline{B} \\ &\overset{3}{\Rightarrow} enn\underline{B}eSe \\ &\overset{1}{\Rightarrow} ennee\underline{S}e \\ &\overset{2}{\Rightarrow} ennee\underline{B}FFe \\ &\overset{4}{\Rightarrow} enneee\underline{F}Fe \\ &\overset{4}{\Rightarrow} enneeen\underline{F}e \\ &\overset{4}{\Rightarrow} enneeenne \end{aligned}$$

4. (10 pts.) For each sentence of Question 3 that is not valid (there may be none such), make as small a change as possible to yield a valid sentence. Write each sentence from that question, possibly modified as above, here. Then provide a parse tree for each.

Ⓐ *No changes are needed since both original sentences are valid.*