Name: _____

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. (No sharing.)
   - **E-books** may be used **subject to the restrictions** noted in class. (Briefly, do only those things with an e-book that are just as easily done with a physical book.)
   - **Computers of any kind** (including tablets, phones, and similar devices) are **not permitted** except when used exclusively as e-book readers.
   - **Network access** of any kind (cell, voice, text, data, ...) is **not permitted**.
   - Write, and draw, carefully. Ambiguous or cryptic answers receive zero credit.
   - Use class and textbook **conventions** for notation, algorithmic options, etc.
   - Questions that ask for **explanations** allocate a sizable fraction of points to those. **Answers without sufficient explanations will score very poorly.**
   - Do not add, remove, detach, or mangle pages (causes scanner problems).
   - Budget your **time**, noting that *number of points = number of minutes*.

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

WAIT UNTIL INSTRUCTED TO CONTINUE TO REMAINING QUESTIONS.

(Do not view any other pages.)

Do not write on this page.
(It is for use in grading only.)

Q	Full	Score
1	1	
2	9	
3	10	
4	10	
5	10	
total	40	

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

   (a) What are the most significant differences between literal and non-literal tokens?

   (b) Provide a code snippet that defines the following tokens in the most suitable way. Include definitions of any required supporting regular expressions or functions. `++`, `/`, and `EXP` (matches 2-character string `**`).

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

$$\begin{aligned} S &\rightarrow S\ S\ F \mid \texttt{i} \mid \texttt{n} \\ F &\rightarrow + \mid - \mid * \mid / \mid ** \end{aligned}$$

(a) For each symbol used above (S, F, $\rightarrow$, $|$, $\texttt{i}$, $\texttt{n}$, $+$, $-$, $*$, $/$, $**$), indicate whether it belongs to the *language* (defined by the grammar) or the *metalanguage* or the *meta-metalanguage*. Provide *brief* explanations **iff** you wish to qualify for any partial credit.

(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) `i n + i * n i - /`

(2) `i i i n n n * * * * *`

[additional space for earlier material]

4. (10 pts.) For each sentence (if any) of Question 3 that is not valid, 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.

[additional space for earlier material]

5. (10 pts.) Repeat Question 4 but provide abstract syntax trees (ASTs) instead of parse trees.

[additional space for earlier material]