Name: _____

1. (1 pt.)
   - **Read all material carefully.**
   - This test is **closed book, closed notes**.
   - However, you may refer to **one** standard Letter-sized sheet of paper (both sides) that has **notes hand-written by you**. If used, this sheet of notes must **include your name** near the top and must be **submitted** along with the quiz.
   - Computing or communication devices of any kind (laptop computers, tablets, phones, calculators, etc.) are not permitted.
   - Network access of any kind (cell, voice, text, data, etc.) is not permitted.
   - 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.

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	4	
3	5	
4	5	
5	15	
6	10	
total	40	

2. (4 pts.) Prove or disprove this claimed equivalence between regular expressions in Python syntax:

$$\texttt{(abc)*} \equiv \texttt{abc*}$$

3. (5 pts.) Prove or disprove this claimed equivalence between regular expressions in Python syntax:

$$\texttt{((a|b)c)+} \equiv \texttt{((ac)|(bc))+}$$

4. (5 pts.) Consider the following context-free grammar.

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

For each symbol used above(S, F, $\rightarrow$, $|$, `i`, `n`, $+$, $-$, $*$, $/$, $**$), indicate whether it belongs to the *language* (defined by the grammar) or the *metalanguage* or the *meta-metalanguage*.

5. (15 pts.) For the grammar of Question 4, clearly state whether the following *sentence* is *valid* (belongs to the language of the grammar). If it is valid then provide a *leftmost derivation* for it *using classroom conventions* (in particular, underlining replaced symbols and annotating arrows with rule numbers); else explain (as precisely as possible) why it is not valid. Ignore all white space. [Hint: It may be easier to answer Question 6 first.]

   `i i * n i * * i + n i`

6. (10 pts.) If the sentence of of Question 5 is not valid then make as small a change as possible to yield a valid sentence (else use the unchanged sentence here). Provide a *parse tree* for the (original or modified) sentence.