Concepts of Programming Languages, CSCI 305, Fall 2021
Homework #6, complete by Oct. 22

1. Create a grammar for a predicate logic language to generate strings such:

   $\forall x\ (A(x) \rightarrow (B(y) \leftrightarrow \neg C(z)) \vee D(w))$

   Your language should allow bracketing (left and right parentheses), the logical binary operators: and ($\wedge$), or ($\vee$), conditional ($\rightarrow$), and biconditional ($\leftrightarrow$). It should also allow the unary operators: not ($\neg$), universal quantification ($\forall$), and existential quantification ($\exists$). Upper case letters of the alphabet denote predicates. Lower case letters of the alphabet denote variables. Predicates only apply to a single variable.

   The order of precedence for your language should be:

   $\neg$, $\forall$, $\exists$ (highest level)
   $\wedge$
   $\vee$
   $\rightarrow$
   $\leftrightarrow$ (lowest)

   Your grammar should use left associativity so that the predicate

   $A(x) \wedge B(x) \wedge B(x)$

   would be interpreted as

   $((A(x) \wedge B(x)) \wedge B(x))$.

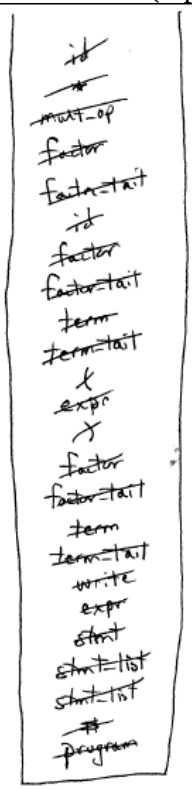
   In order to avoid confusing the predicate logic conditional operator, $\rightarrow$, with the symbol used to define a grammar, use the symbol $\Rightarrow$ to define your grammar.

   string $\Rightarrow$ string $\leftrightarrow$ conditional | conditional
   conditional $\Rightarrow$ conditional $\rightarrow$ disjunction | disjunction
   disjunction $\Rightarrow$ disjunction $\vee$ conjunction | conjunction
   conjunction $\Rightarrow$ conjunction $\wedge$ unary | unary
   unary $\Rightarrow$ $\neg$ pred | $\forall$ variable pred | $\exists$ variable pred | pred
   pred $\Rightarrow$ (string) | Upper (lower)
   upper $\Rightarrow$ A | B | C | …
   lower $\Rightarrow$ a | b | c | …

2. Show all pushes and pops which occur to a stack when parsing the code,
write (A*B) $$

given the following productions and parse table. (5 pts.)

1. program → stmt_list $$
2. stmt_list → stmt stmt_list
3. stmt_list → ε
4. stmt → id := expr
5. stmt → read id
6. stmt → write expr
7. expr → term term_tail
8. term_tail → add_op term term_tail
9. term_tail → ε
10. term → factor factor_tail
11. factor_tail → mult_op factor factor_tail
12. factor_tail → ε
13. factor → (expr)
14. factor → id
15. factor → number
16. add_op → +
17. add_op → -
18. mult_op → *
19. mult_op → /



	id	number	read	write	:=	(	)	+	-	*	/	$
program	1	-	1	1	-	-	-	-	-	-	-	1
stmt_list	2	-	2	2	-	-	-	-	-	-	-	3
stmt	4	-	5	6	-	-	-	-	-	-	-	-
expr	7	7	-	-	-	7	-	-	-	-	-	-
term_tail	9	-	9	9	-	-	9	8	8	-	-	9
term	10	10	-	-	-	10	-	-	-	-	-	-
factor_tail	12	-	12	12	-	-	12	12	12	11	11	12
factor	14	15	-	-	-	13	-	-	-	-	-	-
add_op	-	-	-	-	-	-	-	16	17	-	-	-
mult_op	-	-	-	-	-	-	-	-	-	18	19	-