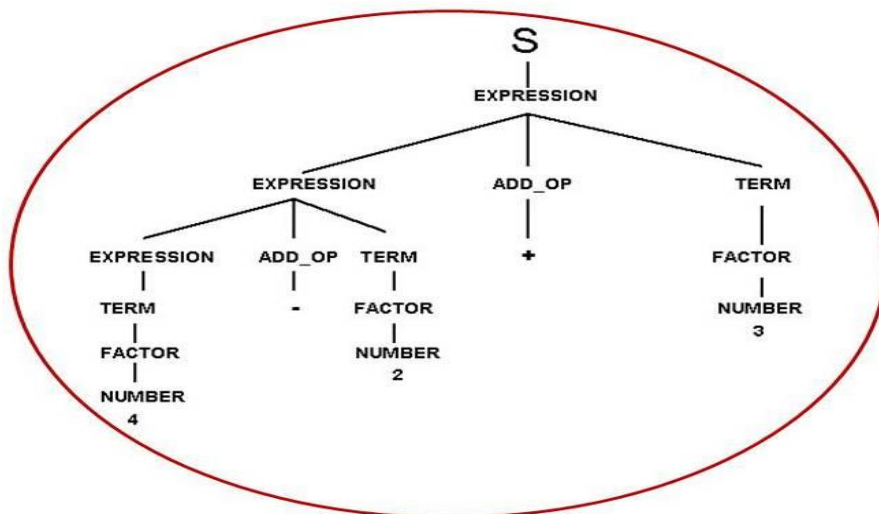
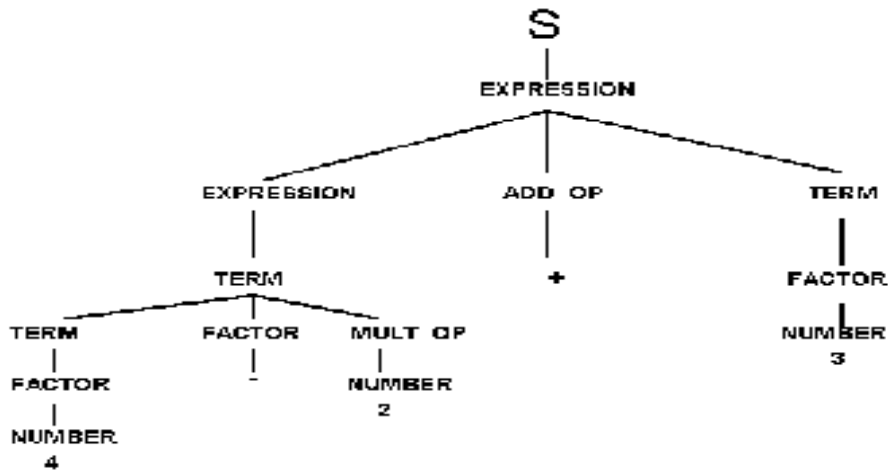
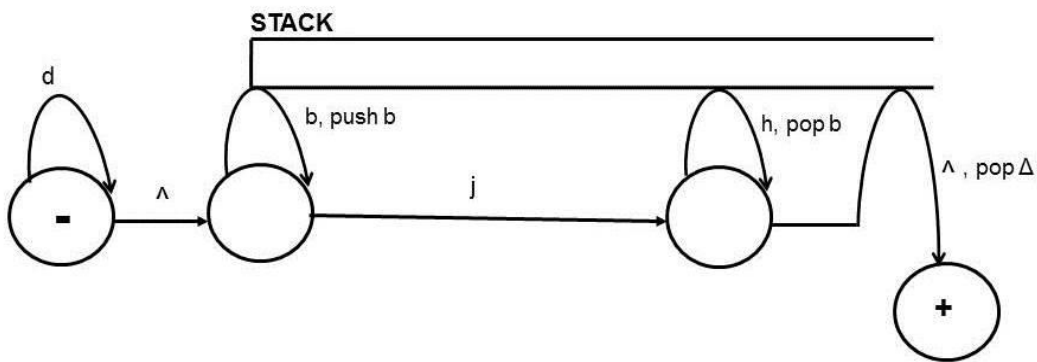


0. [1] Which of the parse trees is generated by the following CFG (Context-Free Grammar)? Select the correct parse tree (by circling the tree or writing "answer" next to the tree).

S → STATEMENT | EXPRESSION
STATEMENT → IDENTIFIER ASSIGN_OP EXPRESSION
EXPRESSION → TERM | EXPRESSION ADD_OP TERM | (EXPRESSION)
TERM → FACTOR | TERM MULT_OP FACTOR | (EXPRESSION)
FACTOR → IDENTIFIER | NUMBER | - FACTOR | (EXPRESSION)
ADD_OP → + | -
ASSIGN_OP → =
MULT_OP → * | /
NUMBER → 1 | 2 | 3 | 4 | 5 | 6 . . .



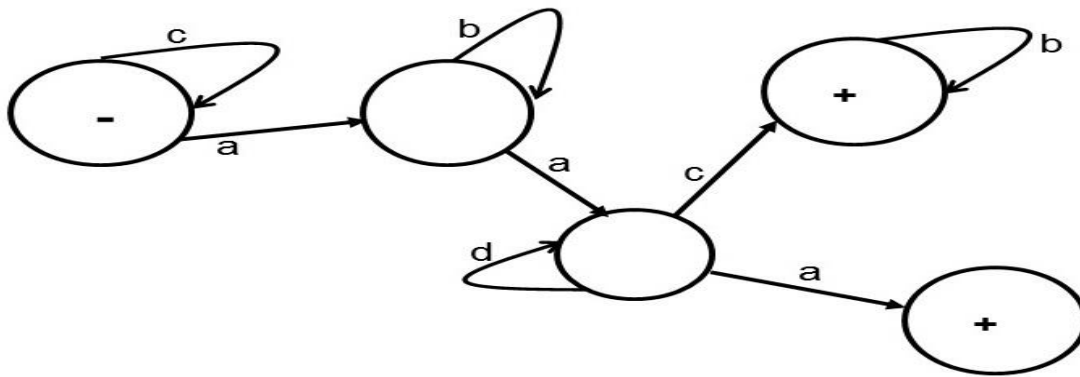
1. [1] Draw a PDA or One-Stack Automaton for $L_1 = \{ d^*b^nh^n : \text{where } n \geq 0 \}$



2. [2] Write a CFG for $L_2 = \{ a^*b^nh^na^* : \text{where } n > 1 \}$

$S \rightarrow AXA$
 $A \rightarrow aA \mid \wedge$
 $X \rightarrow bXh \mid bbjhh$

3. [1] Write the regular expression for the following NFA.



$c^*ab^*ad^*a + c^*ab^*ad^*cb^*$

4. [1] True/False (Assign True to True statements; assign false otherwise)

4a. For every regular expression there is a CFG. **True**

4b. For every Σ^* there is a DFA. **True**

5. [1] Multiple Choice/single answer (select the best answer):

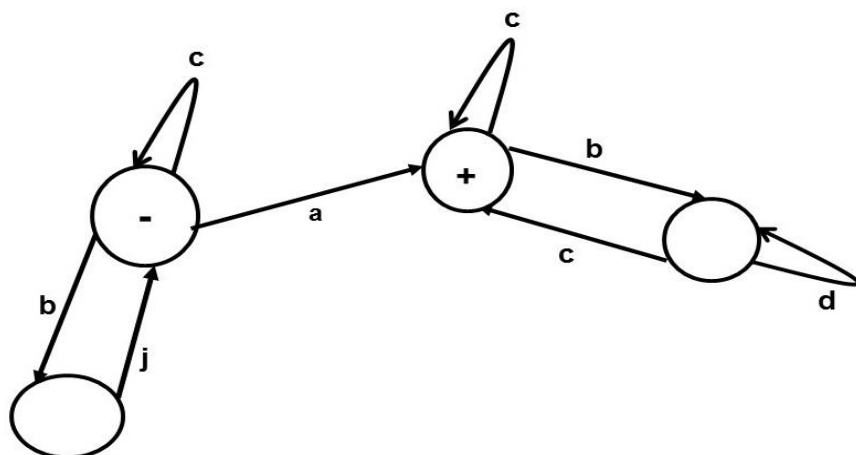
5.1 For every Deterministic Finite Automaton **D** .

- A. there is an infinite language
- B. there is a finite language
- C. there is a regular expression that cannot be defined by a CFG
- D. there is a Non-deterministic Finite Automaton (NFA)
- E. there is a non-regular language
- F. A and C.
- G. B and C
- H. A and E

5.2 $L = \{ c^n d^* h^* b^* a^n d^* : \text{where } n > 0 \}$ is a set of string that **H**

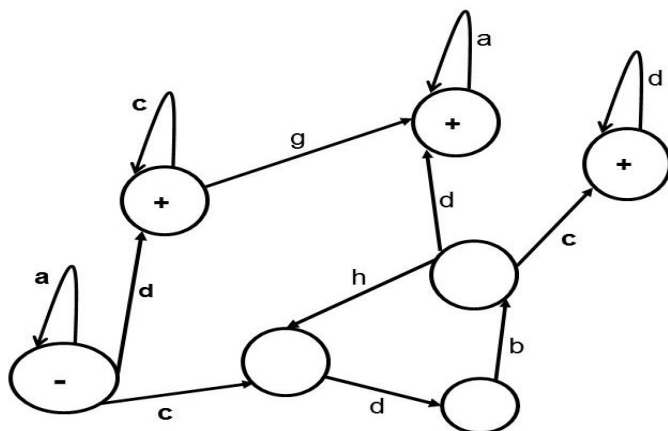
- A. includes cddhbbbaadd
- B. includes cccddhbbbaaadd
- C. includes cccddhbbbaadddd
- D. can be accepted by an NFA
- E. can be defined by a CFG
- F. All of the above
- G. A & E
- H. A, B & E
- I. A & D
- J. B & E

6a. [3] Write the regular expression for the following NFA.



$(c+bj)^*a(c+bd^*c)^*$

6b. [2] Write the regular expression for the following NFA



$a^*dc^* + a^*dc^*ga^* + a^*c(dbh)^*db(hdb)^*da^* + a^*c(dbh)^*db(hdb)^*cd^*$

7. [1] Write a CFG for $L_7 = \{ d^*a^n cb^n d^* : \text{where } n > 1 \}$

CFG:

$S \rightarrow DXD$
 $D \rightarrow dD \mid \wedge$
 $X \rightarrow aXb \mid aacbb$

8. [2] Write a CFG for $L_8 = \{ a^*c^n dedh^n d^*a^* : \text{where } n > 1 \}$

CFG:

$S \rightarrow AXDA$
 $A \rightarrow aA \mid \wedge$
 $X \rightarrow cXh \mid ccdedhh$
 $D \rightarrow dD \mid \wedge$

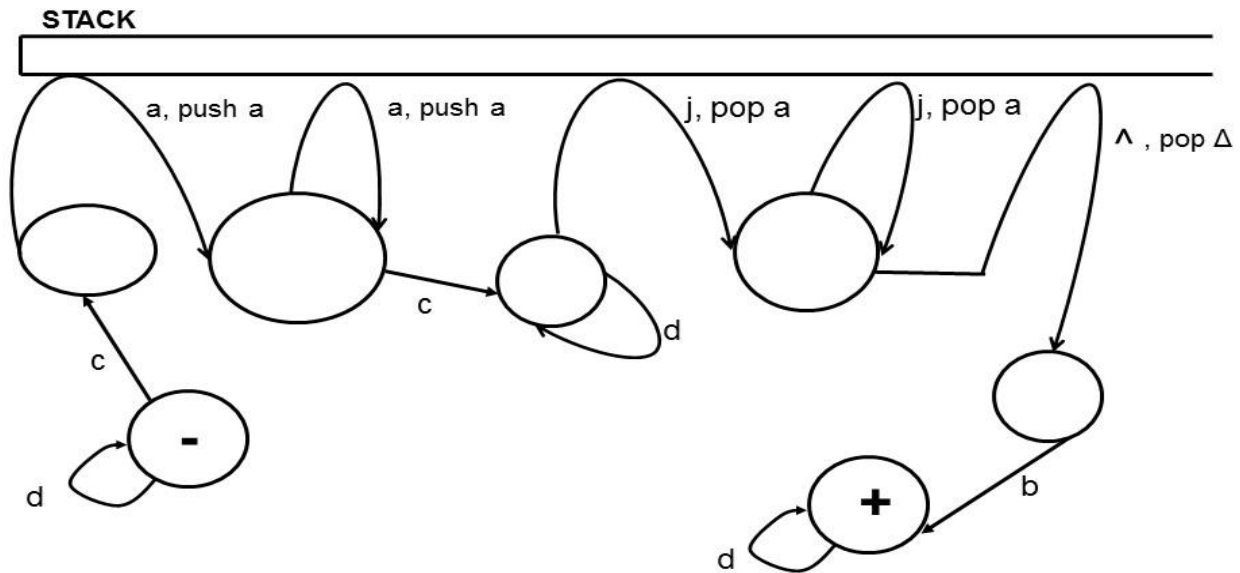
9. [2] Write a CFG for $L_9 = \{ h^n a^n j c^m b^m : \text{where } n > 1, m > 0 \}$

CFG:

$S \rightarrow XjY$
 $X \rightarrow hXa \mid hhaa$
 $Y \rightarrow cYb \mid cb$

10. [2] Draw a PDA or One-Stack Automaton

for $L_{10} = \{ d^*ca^ncd^*j^nb d^*: \text{ where } n > 0 \}$



11.[2] Write a CFG for $L_{11} = \{ j^*h^nd^njc^mb^m : \text{where } n > 0, m > 1 \}$
and give a parse tree for **jhdjjcccbbbb**

CFG:

$S \rightarrow JXjjY$
 $J \rightarrow jJ \mid \wedge$
 $X \rightarrow hXd \mid hd$
 $Y \rightarrow cYb \mid ccbb$

A parse tree for jhdjjcccbbbb

