



PES UNIVERSITY, Bangalore
(Established under Karnataka Act No. 16 of 2013)
Department of Computer Science & Engineering

Automata Formal Languages & Logic

Question Bank - Context Free Grammar

Questions from the Prescribed Textbook

Topic	Exercise No.	Question No's
Context-Free Grammars	5.1	Q7-Q9,Q11,Q15,Q18-25
Parsing and Ambiguity	5.2	Q-6-Q8,Q12-Q19
Context-Free Grammars and programming languages	5.3	Q1,Q2

Extra Questions

1. Construct a context free grammar for $a^n b^m c^k$ where $2n = m$ and $k \geq 2$.
2. Describe the language generated by $G = (\{S, A\}, \{a, b\}, P, S)$. The set of productions P is given as:
 $S \rightarrow aA | bA$
 $A \rightarrow aAa | bAb | aAb | bAa | \lambda$
3. Construct the CFG for the language given by $L = \{0^i 1^j 2^k | i+j=k\}$.
4. Construct the CFG for the language given by $L = \{w_1 c a^n b^m a^i b^j w_2 \mid w_1, w_2 \in \{a, b\}^*, \text{length}(w_1) = \text{length}(w_2), j = 2i, n \leq m\}$.
5. Construct the CFG for the language $L = \{a^n b^m c^k \mid n \neq m \text{ or } m \neq k\}$.
6. Consider the grammar $S \rightarrow 0B \mid 1A, A \rightarrow 0 \mid 0S \mid 1AA, B \rightarrow 1 \mid 1S \mid 0BB$. Given the string 1100, find a leftmost derivation and/or a rightmost derivation with corresponding parse trees. Repeat for the strings 001110 and 001101.
7. Given the CFG $S \rightarrow AB \mid \lambda, A \rightarrow aB, B \rightarrow Sb$, construct a derivation tree for $aaabbbbb$.



PES UNIVERSITY, Bangalore
(Established under Karnataka Act No. 16 of 2013)
Department of Computer Science & Engineering

Automata Formal Languages & Logic

8. For the regular expression $(011+1)^*(01)^*$ obtain a context free grammar.
9. Give a context-free grammar for the language $L \subseteq \{0,1,\# \}^*$, where $L = \{x\#y \mid x \neq y^R, |x| = |y|\}$.
For example, $00\#10, 101\#000 \in L$ but $00\#0, 11\#11 \notin L$
10. Consider the language $L = \{a^m b^{2n} c^{3n} d^p \mid p > m, \text{ and } m, n \geq 1\}$.
 - (a) What is the shortest string in L ?
 - (b) Write a context-free grammar to generate L .
11. Give unambiguous grammar for the following languages.
 - a. $\{w \mid \text{the number of } a\text{'s and } b\text{'s in } w \text{ are equal}\}$
 - b. $\{w \mid \text{the number of } a\text{'s is at least the number of } b\text{'s}\}$.
12. Prove the context free grammar is ambiguous.
 $S \rightarrow aSbT \mid T$
 $T \rightarrow aT \mid bT \mid \lambda$
13. Is the following grammar ambiguous?
 $S \rightarrow iCtS \mid iCtSeS \mid a$
 $C \rightarrow b$
14. Show that $S \rightarrow SaS \mid b$ is ambiguous. Construct an unambiguous equivalent of the grammar.
15. Given the grammar,
 $S \rightarrow P \mid Q$
 $P \rightarrow AA$
 $A \rightarrow aAb \mid ab$



PES UNIVERSITY, Bangalore
(Established under Karnataka Act No. 16 of 2013)
Department of Computer Science & Engineering

Automata Formal Languages & Logic

$Q \rightarrow aQb \mid aRb$

$R \rightarrow bRa \mid ba$

- a. Give description in English of $L(G)$.
- b. Construct the leftmost and rightmost derivation for the string $abab$.

16. Let G be a grammar $S \rightarrow 0B/1A$, $A \rightarrow 0/0S/1AA$, $B \rightarrow 1/1S/0BB$. For the string 00110101 find its leftmost derivation and rightmost derivation tree.

17. Using the grammar $G=(V,T,P,S)$, with $V=\{S\}$ $P=\{S \rightarrow S \mid SS \mid S^* \mid (S) \mid 0 \mid 1 \mid \lambda\}$, give the left most derivation and the corresponding parse tree for the string $(0U(10)^*1)^*$.

18. Construct leftmost and rightmost derivations for the strings, if the language is given

$S \rightarrow AS \mid \epsilon$

$A \rightarrow aa \mid ab \mid ba \mid bb$

Strings:

- a. $aabbba$
- b. $baabab$
- c. $aaabbb$

19. Construct the parse tree for the string $a^*(a+b00)$ for the following CFG using both leftmost and rightmost derivation.

$E \rightarrow I \mid E+E \mid E^*E \mid (E)$

$I \rightarrow a \mid b \mid Ia \mid Ib \mid I0 \mid I1$

20. Construct the parse tree for the string $a^*(a+a)$ for the following CFG using both leftmost and rightmost derivation. The CFG is $E \rightarrow E + E \mid E * E \mid (E) \mid a$.