



**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:  
 $S \rightarrow aA \mid bA$   
 $A \rightarrow aAa \mid bAb \mid aAb \mid bAa \mid \lambda$
3. Construct the CFG for the language given by  $L = \{0^i 1^j 2^k \mid i+j=k\}$ .
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  $aaabbbbbb$ .
8. For the regular expression  $(011+1)^*(01)^*$  obtain a context free grammar.



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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.  $\{w \mid \text{the number of a's and b's in } w \text{ are equal}\}$   
b.  $\{w \mid \text{the number of a's is at least the number of b's}\}$ .
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,  
 $S \rightarrow P \mid Q$   
 $P \rightarrow AA$   
 $A \rightarrow aAb \mid ab$   
 $Q \rightarrow aQb \mid aRb$   
 $R \rightarrow bRa \mid ba$   
a. Give description in English of  $L(G)$ .  
b. Construct the leftmost and rightmost derivation for the string  $abab$ .



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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  $V=\{S\}$   $P=\{S \rightarrow S \cup S | SS | S^* | (S) | 0 | 1 | \lambda\}$ , 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  
 $S \rightarrow AS | \epsilon$   
 $A \rightarrow aa | ab | ba | bb$   
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.  
 $E \rightarrow I | E+E | E^*E | (E)$   
 $I \rightarrow a | b | Ia | Ib | IO | I1$
20. Construct the parse tree for the string  $a^*(a+a)$  for the following CFG using both leftmost and rightmost derivation. The CFG is  $E \rightarrow E + E | E * E | (E) | a$ .