Automata Theory and Computability - 15CS54

Module-3: Review Questions

Sl. No.	Questions	Marks
Context Free Grammar		
1.	Define the following with example. a. Rewrite system b. Context Free Grammar c. Recursive and self embedding grammar	2 each
2.	Write the CFG for following languages. a. L= $\{a^n b^n \mid n>=0\}$ b. L= $\{a^{2n} b^n \mid n>=0\}$ c. L= $\{a^n b^{2n} \mid n>=0\}$ d. L= $\{a^{2n} b^n \mid n>=1\}$ e. L= $\{a^n b^{2n} \mid n>=1\}$ f. L= $\{a^n b^{n+1} \mid n>=0\}$ g. L= $\{a^n b^{n+2} \mid n>=0\}$ h. L= $\{a^{n+3} b^n \mid n>=1\}$ i. L= $\{a^{n+2} b^n \mid n>=1\}$ j. $L = \{a^n b^m : n \neq m\}$ k. $L = \{a^n b^m : n_a(w)>n_b(w)\}$ l. $L=\{ww^R \mid w \varepsilon\{a,b\}^*\}$ m. $L=\{0^m 1^m 2^n \mid m>=1, n>=0\}$ n. $L=\{0^i 1^j \mid i \neq j, i>=0, j>=0\}$ o. $L = \{a^n b^m : n>=0, m>n\}$ p. $L = \{a^n b^{n-3m} : n>=3\}$ q. L={w: |w|mod 3 ≠ |w|mod 2 on {a}} r. L={w: |w|mod 3 >= |w|mod 2 on {a}} s. $L=\{a^m b^m c^k \mid n+2m=k \text{ for } n>=0, m>=0\}$ t. No more than 3 a's on {a,b} u. strings of 0's and 1's having substring '000' v. strings of a's and b's starting with 'a' and ending with 'b' w. strings of a's and b's whose length is multiple of 3. x. $L = \{a^n b^m : n_a(w)>n_b(w)+1$	4 each

Simplifying the grammars		
3.	Write the algorithm *removeunproductive(G)* and *removeunreachable(G).*	5
4.	Simplify the following grammars: a) S→ aA |bB A→ aA |a B→bB D→ ab|Ea E→ aC | d b) S→ AB |AC A→aA |bAa|a, B→bbA|aB|AB C→aCa|aD D→aD|bC c) S→ aA |a | Bb|cC, A→aB, B→a|Aa, C→cCD D→dd	6 each

Proving that a grammar is correct		
5.	Prove that Grammar for $L = \{a^n b^n : n \geq 0\}$ is correct. $R = \{ S \rightarrow aSb,\ S \rightarrow \varepsilon \}$.	10
6.	Prove that the following grammar is correct. $L = \{w \in \{a, b\}^* : \#_a(w) = \#_b(w)\}$ $G = \{\{S, a, b\}, \{a, b\}, R, S\}$ where: $R = \{ \quad S \rightarrow aSb$ $S \rightarrow bSa$ $S \rightarrow SS$ $S \rightarrow \varepsilon \quad \}$.	10

Derivation and Parse trees		
7.	Define the following a. Derivation b. Left-Most Derivation c. Right-Most Derivation d. Parse Tree	4
8.	Obtain Left most derivation (LMD) and Right most derivation (RMD) for the string **+*-xyxy** using the grammar E→+EE |*EE|-EE|x|y	6
9.	Obtain LMD and RMD for **id+id*id** using E→E+E|E*E|(E)|id	6
10.	Consider the CFG with productions E → E+T | T T → T*F |F F → (E) | 0 | 1 Write LMD, RMD and parse tree for the string **0+((1*0)+0)**	6

Ambiguity		
11.	Define the following	4

	a. Ambiguity b. Inherently ambiguous grammar c. Nullable variable d. Useless symbol	
12.	Show that the following grammars are ambiguous. a) S → SbS |a b) S→iCtS |iCtSeS|a, C→b	6 each
13.	Consider the grammar: S → aS |aSbS | ε Is the above grammar ambiguous? Show that the string "aab" has two - i) Parse trees ii) Left most derivations iii) Right most derivations	10
14.	Write inherently ambiguous grammar for a. $L = \{a^n b^n c^m : n, m \geq 0\} \cup \{a^n b^m c^m : n, m \geq 0\}$. b. $L = \{a^n b^n c^m d^m : n, m \geq 1\} \cup \{a^n b^m c^m d^n : n, m \geq 1\}$.	5 each
15.	List three structures in CFG that lead to ambiguity. How to overcome these problems?	6
16.	Remove ambiguity from following grammars. *a)* $S \rightarrow (S) \mid SS \mid \varepsilon$ b) E → E+E|E*E|(E)|id	6 each

Normal Forms		
17	Define CNF and GNF.	2
18	Convert each of the following grammars to Chomsky normal form. **a.** $S \rightarrow aSa$, $S \rightarrow B$, $B \rightarrow bbC$, $B \rightarrow bb$, $C \rightarrow \varepsilon$, $C \rightarrow cC$ **b.** $S \rightarrow ABC$, $A \rightarrow aC \mid D$, $B \rightarrow bB \mid \varepsilon \mid A$, $C \rightarrow Ac \mid \varepsilon \mid Cc$, $D \rightarrow aa$ **c.** $S \rightarrow aTVa$, $T \rightarrow aTa \mid bTb \mid \varepsilon \mid V$, $V \rightarrow cVc \mid \varepsilon$	6 each
19	Convert the following CFG to CNF. ***a***. S → aB | bA; A → a | aS | bAA; B → b | aS| aBB. ***b.*** S → AB | a; A → aab; B → Ac ***c.*** S → aBa| abba; A → ab | AA; B → aB | a **d.** S→aACa; *A →B* | a; *B →C* | c; C→Cc | ε	6 each
20	Write an algorithm for a. removeEps( ) b. atmostoneEps( ) c. removeUnits( ) d. removeMixed(G) ***e.*** RemoveLong(G)	4 each

Push down Automata		
21	Define a) PDA b) Deterministic PDA c) Computation in PDA d) String accept in PDA e) String reject in PDA	2 each
22.	Design a PDA for the following language: $L = \{wcw^R : w \varepsilon \{a,b\}^*\}$. Also Draw the transition diagram. Write the computation (sequence of all configurations) for the input string 'abacaba' and 'abcab'	8
23.	Design PDA along with transition diagram for the following language: $L = \{a^n b^n \mid n >= 0\}$. Write the computation (sequence of all configurations) for the input string 'aabbb' and 'aabb'.	8
24.	Construct PDA for the following language with transition diagram. a. string of balanced parentheses. b. $L= \{a^n b^{2n} \mid n>=1\}$ c. $L = \{ww^R\{w \varepsilon \{a,b\}^*\}$. d. $L = \{w \in \{a, b\}^* : \#_a(w) = \#_b(w)\}$	8 each
25.	Discuss the Techniques for reducing non-determinism with example.	6