to

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Odd Semester Examinations 2023-24

Paper Code: PCC-CS503

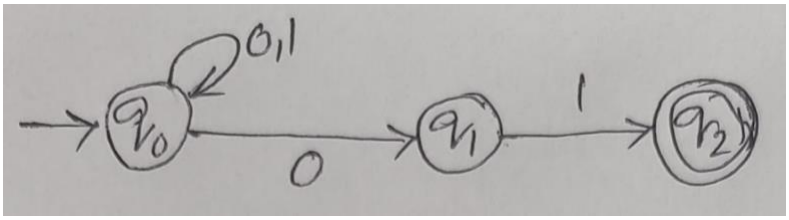
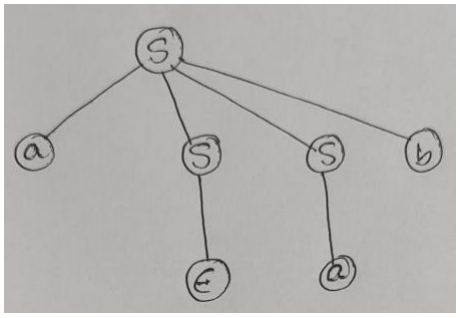
Paper Name: Formal Language & Automata Theory

Time Allotted: **3 Hours** ***Full Marks:*** **70**

Answer all questions.

Special Instructions :(If any)

Sl	Questions	Marks	Mapped CO	Mapped PO	Bloom's
	Group A				
1.(a)	To simplify CFG's following operations are performed. I. Remove useless symbols II. Remove epsilon-productions/lambda-productions III. Remove unit productions The order to perform these operations is (a) I, II, III (b) II, I, III (c) II, III, I (d) III, II, I	1	CO4		L1
1.(b)	Consider the following grammar: S → AE | SB A → bSEa B → aSB | bBE E → aBE | ad Which of the following is/are non-generating symbol(s)? (a) S (b) A (c) E (d) B	1	CO4		L3
1.(c)	Pumping lemma for regular languages is used to check whether a given regular language is finite or not. (a) TRUE (b) FALSE	1	CO3		L1
1.(d)	CFL's are closed under complement. (a) TRUE (b) FALSE	1	CO3		L1
1.(e)	LBA's are same as TM. (a) TRUE (b) FALSE	1	CO3		L1
1.(f)	S → aBc aB → cA Ac → d The above grammar is (a) Unrestricted (b) Context free (c) Regular (d) Context sensitive	1	CO2		L3

1.(g)	Determining whether a string w belongs to L(M), where M is a TM, is undecidable. (a) TRUE (b) FALSE	1	CO1		L1
1.(h)	L(ab*ba*) U L(ba*ab*) = ϵ (epsilon). (a) TRUE (b) FALSE	1	CO1		L3
1.(i)	Turing machines (TM) are "hardwired" i.e., they execute only one program. (a) TRUE (b) FALSE	1	CO1		L1
1.(j)	Consider the following CFG X → XY X → zX | bX | a Y → Ya | Yb | b Any string of terminals, which can be generated by the CFG (a) Has at least one b (b) Ends with a (c) Has no consecutive a's or b's (d) Has at least two a's	1	CO1		L3
	Group B				
2	a) Compute $\delta^*(q_0, 00101)$ by using recursive formula for δ^* [show each step clearly].  	5	CO3		L3
OR	b) Convert the following regular expression into an ϵ-NFA. By using Ken Thompson method. Show each step clearly. a* | b* | c*	5	CO3		L3
3	a) Consider the following derivation tree:  Find a simple grammar G for which this is the derivation tree of the string aab. Then find two more sentences of L(G).	5	CO1		L3
OR	b) Consider the grammar S → aaB B → Aa A → bBb | ϵ Show that the string aabbabba is not in the language generated by this grammar.	5	CO1		L3
4	a) Convert the following CFG into CNF. E → (E) | E + E | EE | -E | 0 | 1	5	CO5		L3
OR	b) Convert the following CFG G into a PDA M with no final states such that L(M) = L(G). S → aBAa | aBB A → bA | Bb B → dB | d	5	CO5		L3

Group C						
5A	a)	Give the complete hierarchy of grammars with their recognizers as well as the form of production rules.	7	CO2		L1
	b)	Design a TM to add two numbers x and y.	8	CO6		L6
OR 5B	a)	Using Chomsky hierarchy, find the highest type number (Type-0/Type-1/Type-2/Type-3 grammar) which can be applied on the following grammars. Justify your answer. i) S → Aa, A → d | Ba, B → abd ii) S → ASB | d, A → aA iii) AAbdD → abdDbdD iv) A → abA	7	CO2		L3
	b)	Design a TM to compute f(x) = 2x.	8	CO6		L6
6A		Draw an NFA which accepts a string containing "the" anywhere in a string of {a–z} e.g., "there" but not "those". Convert the NFA to a minimized DFA by using the concept of distinguishability states.	3+6+6	CO3, CO4		L2
OR 6B	a)	Differentiate between PDA and LBA.	2	CO3		L1
	b)	Prove that the language $\{1^n0^n \mid n \geq 1\}$ is not regular using pumping lemma.	8	CO4		L4
	c)	Given a PDA M_1 having final states. Describe how to construct an equivalent PDA M_2 (without any final state) such that $N(M_2) = L(M_1)$.	5	CO3		L3
7A	a)	Explain with a neat diagram, the working of a Turing model.	5	CO6		L1
	b)	Consider the following grammar G: S → AB A → BB | a B → AB | b Use CYK algorithm to check whether the string *aab* is in L(G).	10	CO4		L3
OR 7B	a)	Explain various types of Turing machines.	5	CO6		L1
	b)	Convert the following grammar into GNF. S → Abb | a A → aaA | B B → bAb	10	CO4		L3