REFNO057696

Roll No. ....

M.Sc. SEMESTER I EXAMINATION 2022-23

COMPUTER SCIENCE

CS - 202 : Theory of Computation

Time : Three hours **Max. Marks : 70**

(WRITE YOUR ROLL NO. AT THE TOP IMMEDIATELY ON THE RECEIPT OF THIS QUESTION PAPER)

NOTE : ATTEMPT FIVE QUESTIONS FROM THE FOLLOWING INCLUDING QUESTION No. 1, WHICH IS COMPULSORY. THE FIGURES IN THE RIGHT-HAND MARGIN INDICATE MARKS.

Marks

1 (a) Let L1 and L2 be regular languages. Is the language $L = \{w: w \in L1, w^R \in L2$ necessarily regular? **[2]**

(b) Is it possible for a context free grammar to be ambiguous? Explain **[2]**

(c) Which language is accepted by Linear Bounded Automata? Does it contain empty string? **[2]**

(d) Construct a grammar which generates all even integers up to 998. **[2]**

(e) Find the language generated by the grammar $S \rightarrow AB$, $A \rightarrow A1|0$, $B \rightarrow 2B|3$. Can the above language be generated by a grammar of higher type? **[2]**

(f) Take $\Sigma = \{a, b\}$ and $\Gamma = \{a, b, c\}$. Define h by h(a)=abb, h(b)= bb. If L is a Regular language denoted by r= (a+b*)aa then find homomorphic image of L. **[2]**

(g) Is the halting problem solvable for deterministic push down automata (PDA); that is given a PDA, can we always predict whether or not the automaton will halt on input w? **[2]**

2 (a) Construct deterministic finite automaton for the language **[5]**

$L= \{w :(n_a (w)+2n_b (w)) \bmod 3 < 2\}$.

(b) Construct an epsilon-NFA accepting the set of all strings over {a, b} for the language **$L=\{a^m b^n: m+n=odd\}$.** Use it to construct an equivalent NFA. **[5]**

(c) Find a regular expression for the following languages: **[4]**

i. $L = \{vwv: v, w \in \{a, b\}^*, |v| \leq 3\}$

ii. $L = \{w : n_a (w) \bmod 5 > 0\}$

3 (a) Construct a minimum state automaton using Myhill-Nerode theorem which is equivalent to a given automaton M whose transition table is defined as: **[6]**

State	Input	
	a	b
$\rightarrow q_0$	q_0	q_3
q_1	q_2	q_5
q_2	q_3	q_4
q_3	q_0	q_5
q_4	q_0	q_6
q_5	q_1	q_4
q_6	q_1	q_3

(b) Construct a Mealy machine which can compute 2's complement, convert it to its equivalent Moore machine. **[4]**

(c) Let $L= \{a^n b^m \mid n \geq 100, m \leq 50\}$ **[4]**

(i) Can you use the pumping lemma to show that L is regular?

(ii) Can you use the pumping lemma to show that L is not regular? Explain your answers.

4 (a) Construct the grammar in Chomsky normal form generating the following language **[5]**

L: $\{wcw^R | w \in \{a, b\}^*\}$

P.T.O.

(b) Remove all unit-productions, all useless productions, and all λ-productions from the grammar [5]

$S \to AA \mid aBB$
$A \to aaA \mid \varepsilon$
$B \to bB \mid bbC \mid A,\ C \to B$

(c) Consider the grammar **G = (V, T, A, P)** with productions [4]

P: $A \to A+A \mid A\text{-}A \mid A*A \mid id$

i. Check whether the grammar is ambiguous or not.

ii. Give a parse tree for string '**5-1+2*2**'

5 (a) What are PDA and NPDA? which one is more powerful and why? Why stack is used in PDA. [5]

(b) Construct NPDA which accepts the language L = {w: $n_a(w) = n_b(w) + 1$}. [5]

(c) Is the language L = {a^{nm}: n and m are prime numbers} context-free? [4]

6 (a) Give the mathematical definition of a Turing machine. Explain its variants with example. [5]

(b) Construct a Turing Machine for **L((101(01)*)**, then find an unrestricted grammar for it. Give a derivation for 10101 using the resulting grammar. [5]

(c) Does the PCP with {(01, 011), (1, 10), (1, 11)} have a solution? If yes, find at least two solutions. (Here, X1 =01, X2 = 1, X3 = 1, Y1 =011, Y2 = 10, Y3 = 11.) [4]

7 Write Short notes on the following: [3.5*4]

i. Rice's theorem

ii. The Halting problem

iii. Closure properties of context free language

iv. Church Turing Thesis

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