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1

Roll Number:____________________ Number of Pages: 02

Thapar Institute of Engineering & Technology, Patiala

Department of Computer Science and Engineering

END SEMESTER EXAMINATION

BE(COE Third Year): Semester-V(2020/21)	Course Code: UCS701 Course Name: Theory of Computation
Jan 25, 2021	Monday, 14.30 – 16.30 Hrs
Time: 2 Hours, M. Marks: 50	Name Of Faculty: Dr Ajay Kumar, Dr Rohit Ahuja

***Note:* Attempt all questions with proper Justification. Without Justification Zero marks will be awarded. Assume missing data, if any, suitably. Attempt any 5 out of 7 questions.**

Q1(a) Convert the Regular expression $1^*(10)^*1^*$ into ε-NFA by using **Thompson's Construction**. Employ ε-closure to convert ε-NFA into an equivalent DFA. Finally convert DFA into an minimized DFA. (2+2 +2)

Q1(b) Consider the unrestricted grammar over the singleton alphabet $\Sigma = \{a\}$, having the start symbol S, and with the following productions. (4)

$S \to AS \mid aT$

$Aa \to aaaA$

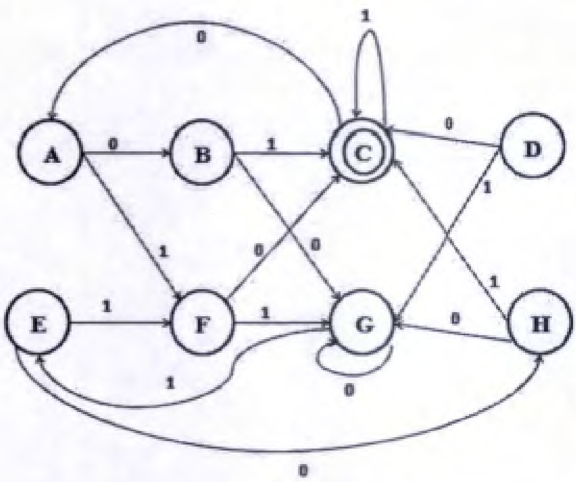
$AT \to T$

$T \to \varepsilon$

Generate the string $w = aaaaaaaaa$ using above grammar.

Q2(a) Prove that the language $L = \{a^i b^j \mid i, j \geq 0 \text{ and } |i - j| \text{ is a prime }\}$ is not a regular language using pumping lemma. (**Note:** 1 is not treated as a prime number. (6)

Q2(b) Design a minimal DFA corresponding to the following diagram. (Consider A as starting and C as final state) (4)



Q3(a) Explain the mechanism of implementing a machine equivalent to Turing Machine using Queue data structure with the help of any example. (3)

Q3(b) Write down the logic to design the Turing Machine for the language $L_3 = \{w \mid w \in \{0+1+2\}^* \text{ and } n_0(w) = n_1(w) = n_2(w)\}$ (7)

$n_0(w)$: number of 0's in the Turing Machine

$n_1(w)$: number of 1's in the Turing Machine

$n_2(w)$: number of 2's in the Turing Machine

Design the Turing machine for language L_3 and explain the processing of string $acbbca$.

Q4 (a) Consider the context-free grammar G over {a, b}, with start symbol S, and with the following productions. (4)

$S \to aaB \mid Abb$

$A \to a \mid aA$

$B \to b \mid bB$

Check whether the given grammar G is ambiguous or not. If it is ambiguous prove it with the help of an example.

Q4(b) Design a Moore Machine to count the number of times substring "raj" appears in a string over alphabet $\Sigma = \{p, r, a, j\}$ and convert the Moore machine into an equivalent Mealy Machine. (6)

Q5(a) Convert the following grammar over $\Sigma = \{a, b, c, d\}$ to the Greibach Normal Form (GNF). (7)

$S \to aSd \mid T$

$T \to bTc \mid \varepsilon$

Q5(b) Prove that context-free languages are not closed under intersection with the help of an example. (3)

Q6 Design regular expression, deterministic finite automaton and regular grammar for the following languages: (10)

a) $L_{6a} = \{w \mid w \in \{a,b\}^*$ and w has b at every odd position and length of w is odd$\}$.

b) $L_{6b} = \{w \mid w \in \{a,b\}^*$ and w has both bb and aba as substring$\}$.

Q7(a) Design context-free grammar and pushdown automata for the language $L = \{a^m b^{n+m} c^n d^k \mid n, m, k \geq 0\}$. Also write the transition function for the pushdown automata. (7)

Q7(b) Write down the Pumping lemma statement for context-free language and specify various conditions used in the Pumping lemma. (3)