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)**
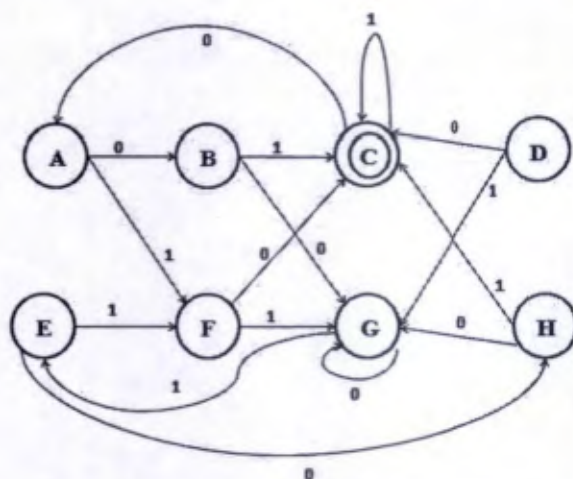$S \rightarrow AS \mid aT$
$Aa \rightarrow aaaA$
$AT \rightarrow T$
$T \rightarrow \varepsilon$
Generate the string $w = aaaaaaaaa$ using above grammar.

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 **(7)**
$L_3 = \{w \mid w \in \{0+1+2\}^* \text{ and } n_0(w) = n_1(w) = n_2(w)\}$
$n_0(w)$: number of 0's in the Turing Machine

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

$S \rightarrow aaB \mid Abb$

$A \rightarrow a \mid aA$

$B \rightarrow b \mid bB$

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"   (6) appears in a string over alphabet $\Sigma = \{p, r, a, j\}$ and convert the Moore machine into an equivalent Mealy Machine.

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

$S \rightarrow aSd \mid T$

$T \rightarrow bTc \mid \varepsilon$

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

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

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

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

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

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