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Reg No.: _____

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Fifth Semester B.Tech Degree Regular and Supplementary Examination December 2020

Course Code: CS301

Course Name: THEORY OF COMPUTATION

Max. Marks: 100

Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks.

Marks

- 1 Design a DFA to accept the set of binary strings ending with 0 (3)
- 2 Show the formal definition of the transition relation in an ϵ -NFA. Illustrate how a transition is performed by an ϵ -NFA. (3)
- 3 List two differences between Moore and Mealy Machines. Give a Mealy machine with the minimum possible number of states that outputs the one's complement of a given binary string. (3)
- 4 Give a regular grammar for the language $\{w \in \{a, b\}^* \mid w \text{ has even number of 'a's and even number of 'b's}\}$ (3)

PART B

Answer any two full questions, each carries 9 marks.

- 5 a) Design a DFA for the language $\{w \in \{0, 1\}^* \mid w, \text{ when considered as an integer, is a multiple of } 3\}$. (6)
b) Design a DFA for the language $\{w \in \{a, b\}^* \mid w \text{ did not contain 'aab' as a substring}\}$. (3)
- 6 a) Find an ϵ -NFA for the language $L(a(a+b)^*b)$ employing the rules for regular expression to ϵ -NFA conversion. (3)
b) Convert the above ϵ -NFA into an equivalent DFA, clearly showing the steps of the standard procedure for the same. (6)
- 7 Find a DFA and a regular expression for the language $\{w \in \{a, b\}^* \mid w \text{ has odd number of 'a's}\}$. (9)

PART C

Answer all questions, each carries 3 marks.

- 8 When a Grammar is said to be ambiguous? Show that the grammar with productions $P = \{E \rightarrow E + E \mid E * E \mid (E) \mid a\}$ for simple arithmetic expressions, is ambiguous. (3)

- 9 Given that, the language $\{a^n b^n \mid n \geq 0\}$ is not regular. Prove that the language $\{w \in \{a, b\}^* \mid w \text{ has equal number of 'a's and 'b's}\}$ is not regular, without using Pumping Lemma. (3)
- 10 Give a formal definition for NPDA. (3)
- 11 Give a PDA which accepts the language $\{a^n b^n \mid n > 0\}$ by empty stack (3)

PART D

Answer any two full questions, each carries 9 marks.

- 12 Is the following language regular? Prove it. (9)
- (i) $\{w \in \{0, 1\}^* \mid \text{the length of } w \text{ is a prime number}\}$
- (ii) L^* (i.e., the Kleene closure of L) where $L = \{a^p \mid \text{where } p \text{ is a prime number}\}$
- 13 Give a CFG with two productions for the language $\{a^{4n} \mid n > 0\}$ and convert it into Chomsky Normal Form. (9)
- 14 Prove that there is a PDA which accepts a language L by final state *if and only if* there is a PDA which accepts L by empty stack. (9)

PART E

Answer any four full questions, each carries 10 marks.

- 15 a) State 'Pumping Lemma for Context Free Languages.' (3)
- b) Prove that the language $\{0^n 1^n 2^n \mid n > 0\}$ is not a CFL. (7)
- 16 a) Design a Turing Machine which accepts the set of all palindromes over $\{a, b\}$ (8)
- b) Show the computations done by the above machine when the input is '1001' by means of Instantaneous Descriptions (IDs). (2)
- 17 Design a Turing Machine that multiplies two unary numbers, by first giving an outline of the strategy of operation of the machine in English sentences. (10)
- 18 a) Give the structure and explain the working of a Multi-tape Turing Machine (5)
- b) Give a formal definition for a Non-deterministic Turing Machine. Show an example NDTM (5)
- 19 a) Prove that if a language L is recursive, so is its complement. (5)
- b) Prove that if both a language L and its complement are recursively enumerable, then L is recursive. (5)
- 20 Prove that 'Turing Machine Halting Problem' is undecidable. (10)

