USN ☐☐☐☐☐☐☐☐☐☐

10CS56

Fifth Semester B.E. Degree Examination, Aug./Sept.2020
Formal Languages and Automata Theory

Time: 3 hrs.   Max. Marks:100

Note: *Answer any FIVE full questions, selecting atleast TWO questions from each part.*

PART – A

1 a. Define following terms :
(i) Language   (ii) Alphabet   (iii) Power set   (iv) Powers of an alphabet   (v) Null string
(05 Marks)

     b. Design a DFA for accepting strings of 0's and 1's containing two consecutive 0's in it.
(05 Marks)

     c. Design a DFA for accepting binary number which are divisible by 5. **(05 Marks)**

     d. Design a DFA for accepting a sequence of a's and b's not ending with abb. **(05 Marks)**

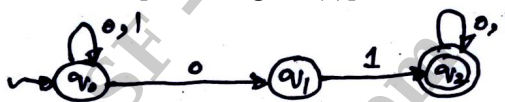**2** a. Convert the following NFA to DFA. [Refer Fig.Q2(a)]

Fig.Q2(a)   **(07 Marks)**

     b. Define $\in$-NFA and $\in$-closure. **(03 Marks)**

     c. Covert the following $\in$-NFA to DFA. [Refer Fig.Q2(c)]

Fig.Q2(c)   **(06 Marks)**

     d. What are the applications of finite automata and regular expressions? **(04 Marks)**

3 a. State and prove pumping lemma of regular languages. **(05 Marks)**

     b. Prove that the language $L = \left\{ww^R : w \in \{a,b\}^* \; w^R \text{ is reverse of } w\right\}$ is not regular.
(05 Marks)

     c. Prove that regular languages are closed under intersection. **(05 Marks)**

     d. Prove that regular languages are closed under homomorphism. **(05 Marks)**

4 a. Define a context free grammar. Design a CFG which accepts all palindromes over a's and b's. **(06 Marks)**

     b. Define the following terms:
(i) Derivation tree   (ii) Yield of a tree   (iii) Leftmost derivation
(iv) Rightmost derivation **(04 Marks)**

     c. Design a CFG for accepting arithmetic expressions involving + and ∗ operators. Check if your CFG is an ambiguous grammar or not. If it is an ambiguous grammar, then get an unambiguous grammar for the same. **(10 Marks)**

PART – B

5 a. Define a PDA and the languages accepted by it. **(05 Marks)**

b. Design a NPDA for the language $L = \{a^n b^{2n} : n \geq 0\}$ **(05 Marks)**

c. Design an NPDA for the language
$$L = \{ a^n b^k c^m : k = n + m, n \geq 0, m \geq 0 \}$$ **(05 Marks)**

d. Convert the following CFG to PDA.
$$S \rightarrow aB \mid bA \qquad A \rightarrow aS \mid bAA \mid a$$
$$B \rightarrow bS \mid aBB \mid b$$ **(05 Marks)**

6 a. When a production becomes useless / nullable? What problem is faced when unit productions present in the grammar? Simplify the following CFG to CNF.
$$S \rightarrow aSb \mid bSa \mid \in \mid SS$$ **(10 Marks)**

b. Define pumping lemma of CFGs. Show that $a^n b^n c^n$ is not a CFL using the same. **(05 Marks)**

c. Prove that context free languages are not closed under intersection and complementation operations. **(05 Marks)**

7 a. Define a Turing Machine. Design a TM for copying string of n 1's present in a tape to its right side. At the end of execution the number of 1's should be 2n in the tape. **(10 Marks)**

b. Design a TM to accept any palindrome of a's and b's. **(08 Marks)**

c. Design a TM that complements a given binary input. **(02 Marks)**

8 a. Define the diagonalization language. Show that for the language Ld, there is no turing machine exists. **(10 Marks)**

b. Define recursive languages. With a diagram explain the relationship of recursive, RE and non RE languages. **(06 Marks)**

c. What is post correspondence problem? Show that it is undecidable. **(04 Marks)**

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