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**Fifth Semester B.E. Degree Examination, Dec.2018/Jan.2019**  
**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 the following with an example :  
 (i) Alphabet (ii) Strings (iii) Languages (iv) Power of an alphabet (06 Marks)
- b. Define DFA. Construct the DFA for the following languages:  
 (i) String of a's and b's ending with abb. (06 Marks)  
 (ii)  $L = \{ w \mid |w| \bmod 5 = 0 \}$  on  $\Sigma = \{ a \}$ . (06 Marks)
- c. Convert the following NFA into equivalent DFA [ Refer Fig.Q1(c) ]. (08 Marks)



Fig.Q1(c)

- 2 a. Write the Regular expressions for following languages:  
 (i)  $L(R) = \{ w \mid w \in \{0, 1\}^* \text{ with atleast 3 consecutive zeros } \}$   
 (ii)  $L = \{ a^n b^m \mid m + n \text{ is even} \}$  (06 Marks)
- b. Prove that every language defined by regular expression is also defined by finite automata. (08 Marks)
- c. Convert the following regular expressions to NFA with  $\epsilon$ -Transitions:  
 (i)  $ab(a + b)^*$  (ii)  $aa(b + a)^*$  (06 Marks)
- 3 a. State and prove pumping lemma for regular languages. (08 Marks)
- b. Prove that the following languages are not regular :  
 (i)  $\{ a^i b^j \mid i > j \}$   
 (ii)  $L = \{ w \mid n_a(w) = n_b(w) \}$  (08 Marks)
- c. Show that if  $L_1$  and  $L_2$  are regular, so is  $L_1 \cap L_2$ . (04 Marks)
- 4 a. Define context free grammar. Obtain the CFG for following languages:  
 (i)  $L = \{ a^n b^m c^k \mid n + 2m = k \text{ for } n \geq 0, m \geq 0 \}$   
 (ii)  $L = \{ ww^R \mid w \in \{a, b\}^* \}$  (08 Marks)
- b. Construct the left most derivation, right most derivation and parse trees for the grammar.  
 $E \rightarrow E + E \mid E - E \mid E * E \mid \text{id}$  for input string "id + id \* id". (06 Marks)
- c. Is the following grammar ambiguous?  
 $S \rightarrow aS \mid X$   
 $X \rightarrow aX \mid a$  (06 Marks)

**PART - B**

- 5 a. Define PDA. What are languages of PDA? Construct the PDA to accept language L.  
 $L = \{ w \subset w^R \mid w \in (a+b)^* \}$  where  $w^R$  is reverse of w. Show the moves made by PDA for string "aabcbaa". (10 Marks)

- b. Define DPDA. Construct DPDA for language  
 $L = \{a^n b^n \mid n \geq 1\}$  (05 Marks)
- c. Obtain the PDA for the grammar  
 $S \rightarrow aABC$   
 $A \rightarrow aB|a$   
 $B \rightarrow bA|b$   
 $C \rightarrow a$  (05 Marks)
- 6 a. Define useless symbols,  $\epsilon$ -production and unit productions. Simplify the following grammar:  
 $S \rightarrow aA \mid a \mid Bb \mid cC$   
 $A \rightarrow aB$   
 $B \rightarrow a \mid Aa$   
 $C \rightarrow cCD$   
 $D \rightarrow ddd$  (08 Marks)
- b. Define CNF. Convert the following grammar to CNF  
 $S \rightarrow 0A \mid 1B$   
 $A \rightarrow 0AA \mid 1S \mid 1$   
 $B \rightarrow 1BB \mid 0S \mid 0$  (06 Marks)
- c. Show that language  $L = \{a^n b^n c^n \mid n \geq 0\}$  is not context free. (06 Marks)
- 7 a. Define Turing machine. Instantaneous description of Turing machine. Obtain a TM for language  
 $L = \{0^n 1^n 2^n \mid n \geq 1\}$  (10 Marks)
- b. Explain the following :  
 (i) Multi-tape turing machines  
 (ii) Non-deterministic Turing machines  
 (iii) Simulating a Turing machine by computer. (10 Marks)
- 8 Write short notes on :  
 a. Halting problem  
 b. Post's correspondence problem  
 c. Un-decidable problem  
 d. Decidability (20 Marks)

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