

PART C — (1 × 15 = 15 marks)

16. (a) Give the regular expression of the language generated by the context free grammar (CFG) given below:

$$S \rightarrow aS | bS | a | b$$

Convert the regular expression to an  $\epsilon$ -NFA. (7)

- (b) Design a Turing machine that accepts the language  $L = \{a^n b^n c^n | n \geq 1\}$ . (8)

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**Question Paper Code : 20369**

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2018.

Fifth/Eighth Semester

Computer Science and Engineering

CS 6503 – THEORY OF COMPUTATION

(Common to Information Technology)

(Regulations 2013)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Give the difference between a deterministic finite automaton (DFA) and a non deterministic finite automaton (NFA).
2. State pumping lemma for regular languages.
3. Consider the context-free grammar (CFG) given below. Give the leftmost derivation for the string  $bbac$  using the grammar.

$$S \rightarrow bS | aT | \epsilon$$

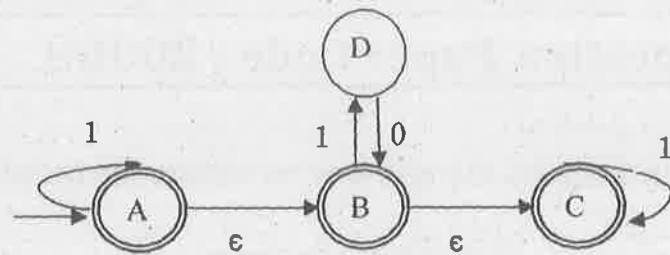
$$T \rightarrow aT | bU | \epsilon$$

$$U \rightarrow aT | \epsilon$$

4. Show that the following grammar is ambiguous:  $S \rightarrow SbS | a$ .
5. What is an instantaneous description (ID) of a push down automaton (PDA)?
6. Convert the following CFG to a push down automaton:  
 $S \rightarrow aS | bS | a | b$ .
7. Differentiate multihead and multitape Turing machines.
8. Give the Chomskian hierarchy of languages.
9. If  $L$  and its complement are recursively enumerable languages, prove that  $L$  is recursive.
10. Define the primitive recursion operation.

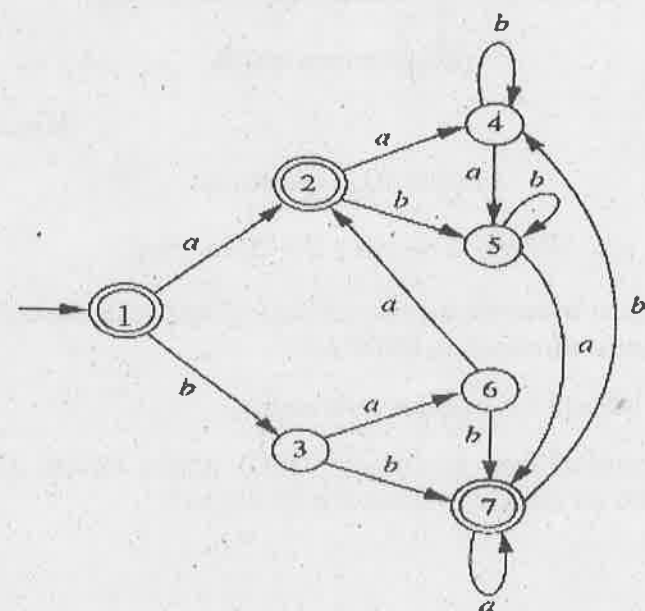
PART B — (5 × 13 = 65 marks)

11. (a) Convert the following  $\epsilon$ -NFA to NFA and then convert the resultant NFA to DFA. (13)



Or

- (b) (i) Prove that a language L is accepted by some NFA if and only if L is accepted by some DFA. (6)  
 (ii) Minimize the following automaton: (7)



12. (a) Simplify the following grammar by eliminating null productions, unit productions and useless symbols and then convert to Chomsky Normal Form (CNF). (13)

$$S \rightarrow ABC \mid BaB$$

$$A \rightarrow aA \mid BaC \mid aaa$$

$$B \rightarrow bBb \mid a \mid D$$

$$C \rightarrow CA \mid AC$$

$$D \rightarrow \epsilon$$

Or

- (b) Convert the following grammar to Greibach normal form (GNF): (13)

$$S \rightarrow AB, A \rightarrow BS \mid b, B \rightarrow SA \mid a.$$

13. (a) (i) Prove that the language  $L = \{a^n b^n c^n \mid n \geq 1\}$  is not context free using pumping lemma: (8)  
 (ii) What is a deterministic push down automaton? Comment on the language accepting capabilities of a deterministic push down automaton. (5)

Or

- (b) Convert the following PDA M to CFG: (13)

$M = (\{q_0, q_1\}, \{0, 1\}, \{X, Z_0\}, \delta, q_0, Z_0, \Phi)$  and  $\delta$  is given by

$$\delta(q_0, 0, Z_0) = \{(q_0, XZ_0)\}, \delta(q_1, 1, X) = \{(q_1, \epsilon)\},$$

$$\delta(q_0, 0, X) = \{(q_0, XX)\}, \delta(q_1, \epsilon, X) = \{(q_1, \epsilon)\},$$

$$\delta(q_0, 1, X) = \{(q_1, \epsilon)\}, \delta(q_1, \epsilon, Z_0) = \{(q_1, \epsilon)\}.$$

14. (a) (i) Give the five-tuple representation of a Turing machine and explain the representation. Define the language accepted by a Turing machine. (5)

- (ii) Consider the following Turing machine  $M = (\{q_1, q_2, q_3, q_4\}, \{0, 1\}, \{0, 1, X, B\}, \delta, q_1, B, q_4)$  where  $\delta$  is given as

$$\delta(q_1, 0) = (q_2, X, R)$$

$$\delta(q_2, 0) = (q_2, X, R)$$

$$\delta(q_2, 1) = (q_3, X, R)$$

$$\delta(q_3, 0) = (q_2, X, R)$$

$$\delta(q_3, 1) = (q_3, X, R)$$

$$\delta(q_3, B) = (q_4, X, R)$$

What will be the initial and final configurations of the Turing machine for the input string  $w = 0101$ ? (8)

Or

- (b) Design a Turing machine that accepts the language  $L = \{ss \mid s \text{ is in } \{a, b\}^*\}$ . (13)

15. (a) (i) If L1 and L2 are recursively enumerable languages, prove that the union of L1 and L2 is also recursively enumerable. (8)

- (ii) Write notes on polynomial-time reductions. (5)

Or

- (b) What is a universal Turing Machine? Explain the procedure to construct the universal Turing machine. (13)