

$$\delta(q_0, 1, X) = (q_0, XX)$$

$$\delta(q_0, 0, X) = (q_0, X)$$

$$\delta(q_0, \epsilon, X) = (q_1, \epsilon)$$

$$\delta(q_1, \epsilon, X) = (q_1, \epsilon)$$

$$\delta(q_1, 0, X) = (q_1, XX)$$

$$\delta(q_1, 0, Z_0) = (q_1, \epsilon)$$

- (c) (i) Define a deterministic push down automata (DPDA). Write a DPDA which accepts the language $L = \{a^n b^m c^n \mid n \text{ and } m \text{ are arbitrary positive integers}\}$.
- (ii) Prove that every language accepted by a PDA by final state is also accepted by some PDA by empty stack.

5. Attempt any **two** parts of the following :

- (a) What do you understand by Instantaneous Description of a Turing Machine ? Design a Turing machine that computes the integer function f which multiplies two given positive integers defined as follows :
- $$f(m, n) = m * n.$$
- (b) (i) Let $A = \{001, 0011, 11, 101\}$ and $B = \{01, 111, 111, 010\}$. Does the pair (A, B) have Post Correspondence (PC) solution ? Does the pair (A, B) have Modified Post Correspondence (MPC) solution ?
- (ii) Prove that recursively enumerable languages are closed under intersection.
- (c) What do you understand by undecidable problem ? State the Halting Problem and prove that Halting problem is undecidable.

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 0112

Roll No.

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B. Tech.

(SEM. IV) THEORY EXAMINATION 2011-12

THEORY OF AUTOMATA AND FORMAL LANGUAGES

Time : 3 Hours

Total Marks : 100

Note : (1) Attempt **all** questions.

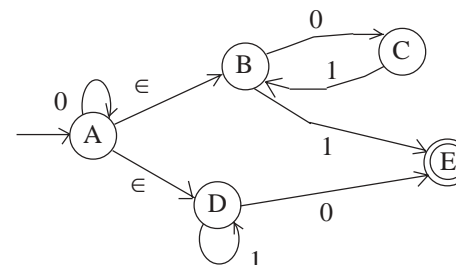
(2) All questions carry equal marks.

(3) Notations/Symbols/Abbreviations used have usual meanings.

(4) Make suitable assumption(s), wherever required.

1. Attempt any **two** parts of the following :

- (a) Obtain deterministic finite automata (DFA) with minimum number of states which accepts the same language which is accepted by the following nondeterministic finite automata (NFA).



- (b) (i) Draw finite automata recognizing the following language :

$$1(1 + 10)^* + 10(0 + 01)^*$$

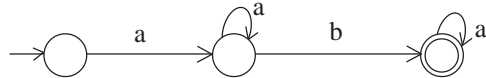
- (ii) Determine whether complement of a nonregular language is also nonregular. Prove your answer.
- (c) (i) Simplify the regular expression $(r(r + s)^*)^+$.
- (ii) Draw the finite automata which accepts all the strings containing both 11 and 010 as substrings.

2. Attempt any **two** parts of the following :

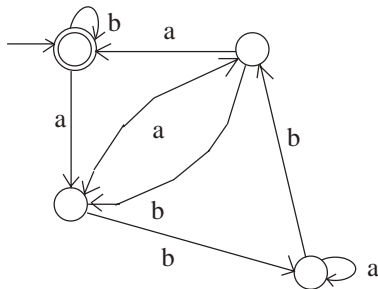
- (a) State pumping lemma for regular languages. Use pumping lemma to prove that the language L, defined as follows, is not regular.

$$L = \{0^m 1^n \mid m \text{ and } n \text{ are positive integers and } m \neq n\}.$$

- (b) (i) Explain the difference between Moore machine and Mealy machine. Describe with the help of an example how a Moore machine can be converted to a Mealy machine.
- (ii) Design a finite automata which accepts the complement of the language accepted by the following automata :



- (c) Obtain the regular expression corresponding to the following automata :



3. Attempt any **two** parts of the following :

- (a) (i) Consider the grammar G given as follows :

$$S \rightarrow AB \mid aaB$$

$$A \rightarrow a \mid Aa$$

$$B \rightarrow b$$

Determine whether the grammar G is ambiguous or not. If G is ambiguous then construct an unambiguous grammar equivalent to G.

- (ii) The family of context free languages is closed under star-closure but is not closed under difference.
- (b) (i) Given a context free Grammar G. Write an algorithm (if it exists) to determine whether $L(G)$ is infinite or not.
- (ii) Given the following CFG having S as start symbol, find an equivalent CFG with no useless symbols :

$$S \rightarrow aAa \mid bSb \mid \epsilon$$

$$A \rightarrow C \mid a$$

$$B \rightarrow C \mid b$$

$$C \rightarrow CDE \mid \epsilon$$

$$D \rightarrow A \mid B \mid ab$$

- (c) What is difference between Chomsky normal form (CNF) and Greibach normal form (GNF) ? Convert the following grammar in Greibach normal form :

$$S \rightarrow AB$$

$$A \rightarrow BSB \mid BB \mid b$$

$$B \rightarrow a \mid aAb$$

4. Attempt any **two** parts of the following :

- (a) Construct a PDA that accepts the language L over $\{0, 1\}$ by empty stack which accepts all the strings of 0's and 1's in which number of 0's are twice of the number of 1's.
- (b) Convert the given PDA M to equivalent context free grammar. The PDA M is defined as $M(\{q_0, q_1\}, \{0, 1\}, \{X, Z_0\}, \delta, q_0, Z_0, \{q_1\})$ where δ is given as follows :

$$\delta(q_0, 1, Z_0) = (q_0, XZ_0)$$