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10CS56

# Fifth Semester B.E. Degree Examination, June/July 2016

## Formal Languages and Automata Theory

Time: 3 hrs. Max. Marks:100

**Note:** ***Answer FIVE full questions, selecting at least TWO questions from each part.***





### PART – A

1 a. Define the following with examples: i) Alphabet, ii) String. **(04 Marks)**

b. Define DFA. Write the DFA's for the following languages on $\Sigma = \{a, b\}$.
i) The set of all strings containing the substring 'ab'.
ii) $L = \{\omega \mid |\omega| \bmod 3 = 0\}$ **(08 Marks)**

c. Convert the following NFA to its equivalent DFA.

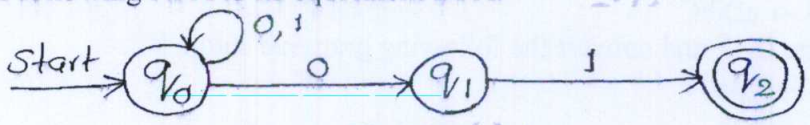


Fig.Q1(c) **(08 Marks)**

2 a. Define a regular expression. Also write the regular expressions for the following languages.
i) The set of all strings ending in the substring '00' on $\Sigma = \{0, 1\}$
ii) $L = \{a^n b^m \mid n \geq 4, m \leq 3\}$. **(08 Marks)**

b. Prove that every language defined by a regular expression is also defined by a finite automation. **(08 Marks)**

c. Write the $\epsilon$-NFA for the regular expression $ab(a + b)^*$. **(04 Marks)**

3 a. State and prove pumping lemma for regular languages. **(07 Marks)**

b. Show that the language $L = \{a^n b^n \mid n \geq 0\}$ is not regular. **(06 Marks)**

c. Minimize the following DFA using table filling algorithm. **(07 Marks)**

| $\delta$ | 0 | 1 |
|---|---|---|
| $\rightarrow q_1$ | $q_2$ | $q_3$ |
| $q_2$ | $q_3$ | $q_5$ |
| $*q_3$ | $q_4$ | $q_3$ |
| $q_4$ | $q_3$ | $q_5$ |
| $*q_5$ | $q_2$ | $q_5$ |

4 a. Define CFG. Design CFG's for the following languages:
i) $L = \{a^n b^{2n} \mid n \geq 0\}$
ii) $L = \{\omega\omega^R / \omega \in \{a, b\}^*\}$ **(08 Marks)**

b. Write the LMD, RMD and parse tree for the string '+*–xyxy' using the grammar
$E \rightarrow +EE \mid *EE \mid -EE \mid x \mid y$ **(06 Marks)**

c. What is an ambiguous grammar? Show that the following grammar is ambiguous:
$E \rightarrow E + E \mid E * E \mid (E) \mid id$ **(06 Marks)**

## PART – B

5 a. Define a PDA and explain the working of it with a neat diagram. **(05 Marks)**

b. Design a PDA for the language $L = \{\omega\omega^R \mid \omega \in \{a, b\}^+\}$. Draw the transition diagram and also write the sequence od ID's for the string 'abba'. **(10 Marks)**

c. Convert the following CFG to an equivalent PDA:

$S \rightarrow aA$

$A \rightarrow aABC|bB|a$

$B \rightarrow b$

$C \rightarrow c$ **(05 Marks)**

6 a. Eliminate the useless symbols and productions from the following grammar.

$S \rightarrow AB|AC$

$A \rightarrow aA|bAa|a$

$B \rightarrow bbA|aB|AB$

$C \rightarrow aCa|aD$

$D \rightarrow aD|bC$ **(07 Marks)**

b. Define CNF and convert the following grammar into CNF.

$S \rightarrow ABa$

$A \rightarrow aab$

$B \rightarrow Ac$ **(06 Marks)**

c. Prove that the family of context-free languages is closed under union, concatenation and star-closure. **(07 Marks)**

7 a. Define a turing machine and explain the working of a basic turing machine with a neat diagram. **(08 Marks)**

b. Design a turing machine for the language $L = \{a^n b^n \mid n \geq 1\}$. Write the transition diagram for the same and also, indicate the moves made by the turing machine for the input 'aabb'. **(12 Marks)**

8 Write short notes on:

a. Multitape turing machine

b. Post's correspondence problem

c. Applications of context-free languages

d. Chomsky hierarchy **(20 Marks)**

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