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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.

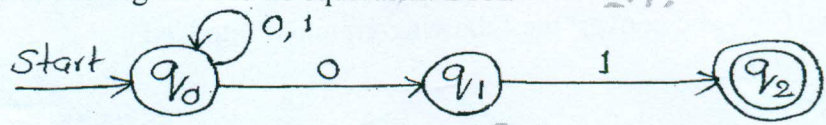


Fig.Q1(c)

(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)  $L = \{\omega \omega^R \mid \omega \in \{a, b\}^*\}$  (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)

Important Note : 1. On completing your answers, carefully draw diagonal cross lines on the remaining blank pages.  
2. Any revealing of identification, appeal to evaluator and/or equations written eg. 42+8 = 50, will be treated as malpractice.

**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 of 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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