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06CS56

Fifth Semester B.E. Degree Examination, May/June 2010
Formal Languages and Automata Theory

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Define the following terms, with an example for each:
i) String ii) Alphabet iii) Powerset iv) Language. **(08 Marks)**

b. Mention the differences between DFA, NFA and ∈-NFA. **(04 Marks)**

c. Convert the following ∈-NFA to DFA. [Refer Fig.Q1(c)]. **(08 Marks)**

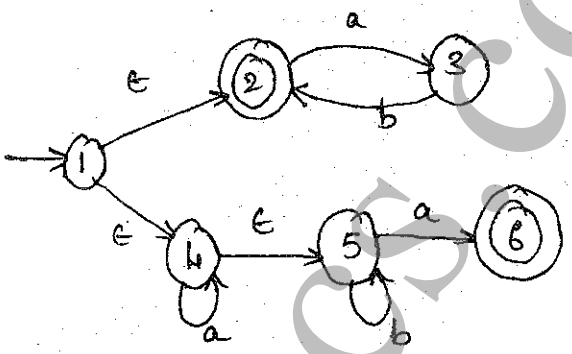

Fig.Q1(c)

2 a. Define a regular expression. Find regular expression for the following languages on {a, b}:
i) $L = \{ a^{2n} b^{2m} : n \geq 0, m \geq 0 \}$ ii) $L = \{ w : |w| \bmod 3 = 0 \}, w \in \{a, b\}^*$ **(08 Marks)**

b. Prove that if L and M are regular languages, then so is $L \cap M$. **(06 Marks)**

c. Convert the regular expression $(01 + 1)^*$ to an ∈-NFA. **(06 Marks)**

3 a. State pumping lemma for regular languages. Prove that the language $\{a^n b^n \mid n \geq 1\}$ is non-regular. **(10 Marks)**

b. Define distinguishable and indistinguishable states. Minimize the following DFA using table filling algorithm.

f		0	1
→	A	B	F
	B	G	C
*	C	A	C
	D	C	G
	E	H	F
	F	C	G
	G	G	E
	H	G	C

(10 Marks)

4 a. Define CFG. Obtain CFG for the following languages:
i) $L = \{ ww^R \mid w \in \{a, b\}^* \}$, w^R is the reversal of w } ii) L = { w : w has a substring ab} **(10 Marks)**

b. What is an ambiguous grammar? Show that the following grammar is ambiguous.
$E \rightarrow E + E \mid E - E \mid E * E \mid E / E \mid (E) \mid a$
where E is the start symbol. Find the unambiguous grammar. **(10 Marks)**

PART – B

5 a. Define PDA. Design PDA to accept the following language by final state.

$L = \{ w \mid w \in \{a, b\}^*, N_a(w) = N_b(w) \}$

Draw the graphical representation of PDA. Also, show the moves made by the PDA for the string abbaba. **(12 Marks)**

b. Convert the following CFG to PDA.

$S \rightarrow aABB \mid aAA$

$A \rightarrow aBB \mid a$

$B \rightarrow bBB \mid A$

$C \rightarrow a$ **(08 Marks)**

6 a. What are useless symbols? Eliminate $\in$, unit and useless productions from the following grammar:

$S \rightarrow Aa\ A \mid CA \mid BaB$

$A \rightarrow aaBa \mid CDA \mid aa \mid DC$

$B \rightarrow bB \mid bAB \mid bb \mid aS$

$C \rightarrow Ca \mid bC \mid D$

$D \rightarrow bD \mid \in$ **(10 Marks)**

b. What is CNF and GNF? Obtain the following grammar in CNF:

$S \rightarrow aBa \mid abba$

$A \rightarrow ab \mid AA$

$B \rightarrow aB \mid a$ **(10 Marks)**

7 a. Prove that the context free languages are closed under union, concatenation and reversal. **(10 Marks)**

b. Design a turning machine that performs the following function:

$q_0 w \vdash^* q_f ww$ for any $w \in \{1\}^*$ **(10 Marks)**

8 Write short notes on:

a. Multitape TM

b. Post correspondence problem

c. Chomsky hierarchy

d. Applications of regular expressions. **(20 Marks)**

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06CS56

Fifth Semester B.E. Degree Examination, December 2010
Formal Languages and Automata Theory

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. Assume any missing data, if any.

Important Note : 1. On completing your answers, compulsorily 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 – A

1 a. Define the following terms:
i) Alphabet ii) Power of an alphabet iii) Strings iv) Language **(04 Marks)**

b. Write the DFA's for the following languages over $\Sigma = \{a, b\}$:
i) The set of all strings ending with abb
ii) The set of all strings not containing the substring aab
iii) $L = \{a\ w\ a \mid w \in (a + b)^*\}$
iv) $L = \{w \mid |w| \bmod 3 = 0\}$ **(08 Marks)**

c. Convert the following NFA to its equivalent DFA. **(08 Marks)**

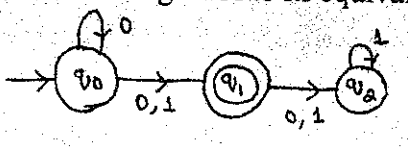

Fig.Q1(c)

2 a. Compute $\in$- closure of each state from the following $\in$ - NFA : **(04 Marks)**

	$\in$	a	b
→p	{ r }	{ q }	{ p, r }
q	ϕ	{ p }	ϕ
r	{ p, q }	{ r }	{ p }
*s	{ p }	{ p }	{ p }

b. Define regular expression. Write the regular expression for the following languages:
i) $L = \{a^n\ b^m \mid n \le 4, m \ge 2\}$
ii) Strings of 0's and 1's having no two consecutive zeros
iii) Strings of 0's and 1's whose lengths are multiples of 3. **(06 Marks)**

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

d. Obtain a regular expression from the following DFA using state elimination method:

Fig.Q2(d)

(06 Marks)

3 a. Apply pumping lemma for the following languages and prove that they are not regular :
i) $L = \{w\ w^R \mid w \in (0 + 1)^*\}$ ii) $L = \{a^n\ b^n \mid n \ge 0\}$ **(10 Marks)**

b. Prove that the regular languages are closed under complementation. **(04 Marks)**

c. Consider the two DFA's shown below. Using table filling algorithm, show that the language accepted by both the DFA's is same. **(06 Marks)**

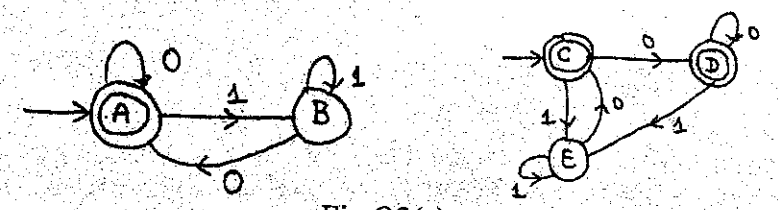

Fig.Q3(c)

4 a. Define context free grammar. Write the grammar for the following languages :
i) $L = \{ 0^{n+2} 1^n \mid n \geq 1\}$ ii) $L = \{a^n b^m \mid m > n \text{ and } n \geq 0\}$ **(07 Marks)**

b. Consider the grammar G, with productions:
$S \rightarrow Ab\ B$
$A \rightarrow aA \mid \in$
$B \rightarrow aB \mid bB \mid \in$
Give leftmost derivation, right most derivation and parse tree for the string aaabab. **(08 Marks)**

c. What is ambiguous grammar? Show that the following grammar is ambiguous.
$S \rightarrow AB \mid aaB$
$A \rightarrow a \mid Aa$
$B \rightarrow b$ **(05 Marks)**

PART – B

5 a. Define PDA. Describe the language accepted by PDA. **(04 Marks)**

b. Construct a PDA that accepts the language $L = \{a^n b^n \mid n \geq 1\}$. Give the graphical representation for PDA obtained. Show the instantaneous description of the PDA on the input string aaabbb. **(10 Marks)**

c. Obtain a PDA equivalent to the following grammar:
$S \rightarrow AS \mid \in$
$A \rightarrow 0A1 \mid A1 \mid 01$ **(06 Marks)**

6 a. What are useless symbols? Explain with an example. **(04 Marks)**

b. Obtain the nullable set and hence eliminate all $\in$ - productions from the following grammar:
$S \rightarrow aAa \mid AB$
$A \rightarrow BS \mid aBa \mid \in$
$B \rightarrow aB \mid \in$ **(06 Marks)**

c. Define CNF. Convert the following grammar to CNF:
$S \rightarrow aSb \mid ab \mid Aa$
$A \rightarrow aab$ **(10 Marks)**

7 a. Define turing machine. Explain with a diagram, general structure of multitape turing machine. **(06 Marks)**

b. Design a turing machine to accept the language $L = \{0^n 1^n \mid n \geq 1\}$. Write its transition diagram and give instantaneous description for the input 0011. **(14 Marks)**

8 Write short notes on the following : **(20 Marks)**

a. Application of regular expressions
b. Post's correspondence problem
c. Recursive languages
d. Universal turing machine

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