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10CS56

Fifth Semester B.E. Degree Examination, Jan./Feb. 2021

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. Mention the differences between DFA, NFA and ϵ -NFA. (04 Marks)
- b. Design DFA for following languages over $\Sigma = \{a, b\}$
 - (i) The set of all strings not containing the substring aab.
 - (ii) Set of strings with odd number of a's and odd number of b's.
 - (iii) Strings ending with abb. (06 Marks)
- c. Design an NFA accepting the set of all strings ending with '01' over $\Sigma = \{0, 1\}$ and convert it to equivalent DFA by subset construction method. (10 Marks)
- 2 a. Convert the following ϵ -NFA to equivalent DFA.

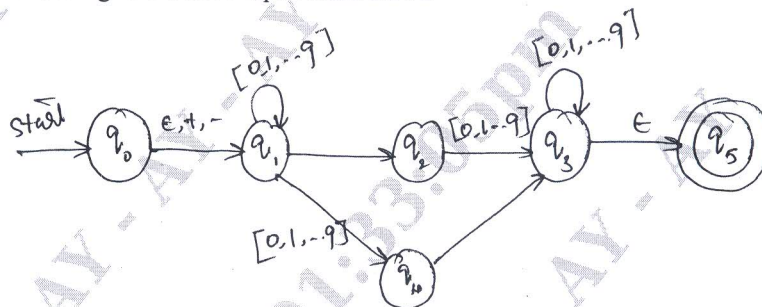


Fig.Q2(a) ϵ -NFA for decimal number

(07 Marks)

- b. Define regular expression and also write regular expressions for the following languages:
 - (i) $L = \{a^n b^m \mid n \geq 4 \text{ and } m \leq 3\}$
 - (ii) $L = \{\omega : |\omega| \bmod 3 = 0, \omega \in \{a, b\}^*\}$ (06 Marks)
- c. Convert the Regular expression $a^* + b^*c$ to ϵ -NFA. (03 Marks)
- d. Obtain the regular expression for the following FA using state elimination technique:

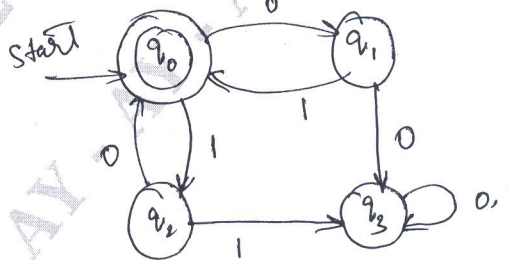


Fig.Q2(d)

(04 Marks)

- 3 a. State and prove pumping lemma for regular languages. (05 Marks)
- b. Show that the language $L = \{0^n \mid 0^n \mid n \geq 1\}$ is not regular using pumping lemma. (03 Marks)

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.

- c. What are distinguishable and indistinguishable states? Minimize the following DFA using table filling algorithm. (10 Marks)

δ	a	b
$\rightarrow A$	B	E
B	C	F
* C	D	H
D	E	H
E	F	I
* F	G	B
G	H	B
H	I	C
* I	A	E

- d. Consider the following two DFA's, M_1 and M_2 . Construct the product automation which simulates both M_1 and M_2 i.e. intersection. [Refer Fig.Q3(d)]

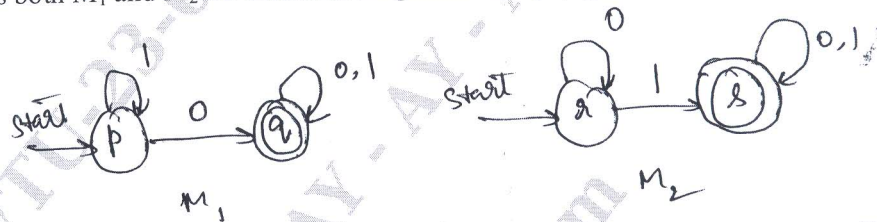


Fig.Q3(d)

(02 Marks)

- 4 a. Define a Context-Free Grammar (CFG) and also obtain CFG's for the following languages:
 (i) $L = \{0^i 1^j \mid i \neq j, i \geq 0 \text{ and } j \geq 0\}$ (08 Marks)
 (ii) $L = \{(011 + 1)^m (01)^n \mid m, n \geq 0\}$
 b. What is an ambiguous grammar? Show that the following grammar is ambiguous.
 $E \rightarrow E + E \mid E * E \mid (E) \mid a$ where E is the start symbol. Find the unambiguous grammar. (08 Marks)
 c. Discuss the applications of CFG. (04 Marks)

PART - B

- 5 a. Give the formal definition of PDA. Design a PDA for the language $L = \{\omega\omega^R \mid \omega \in \{a, b\}^*\}$. Also, draw the transition diagram for the constructed PDA. Write the Instantaneous Description (ID) for the string "abbba". (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? For the following grammar
 $S \rightarrow aAa \mid bBb \mid \epsilon$
 $A \rightarrow C \mid a$
 $B \rightarrow C \mid b$
 $C \rightarrow CDE \mid \epsilon$
 $D \rightarrow A \mid B \mid ab$
 (i) Eliminate ϵ - productions.
 (ii) Eliminate unit productions (if any)
 (iii) Eliminate useless symbols (if any) (10 Marks)

- b. Define Chomsky normal form. Also, convert the following CFG to CNF.
 $S \rightarrow AB \mid a$
 $A \rightarrow aab$
 $B \rightarrow Ac$ (06 Marks)
- c. Prove that the context-free languages are closed under union. (04 Marks)
- 7 a. Define a Turing machine. (02 Marks)
- b. Design a Turing machine to accept the following language: $L = \{a^n b^n \mid n \geq 1\}$. Also show the sequence of moves made by the TM for the string "aabb". Write the transition diagram. (10 Marks)
- c. Explain multi-tape Turing machine and compare the same with universal Turing machine. (08 Marks)
- 8 Write short notes on:
- Application of Regular Expressions
 - Universal Turing Machine
 - Post correspondence problem
 - Recursive language
- (20 Marks)
