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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 ∈-NFA. **(04 Marks)**

b. Design DFA for following languages over Σ = {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 Σ = {0, 1} and convert it to equivalent DFA by subset construction method. **(10 Marks)**

2 a. Convert the following ∈-NFA to equivalent DFA.

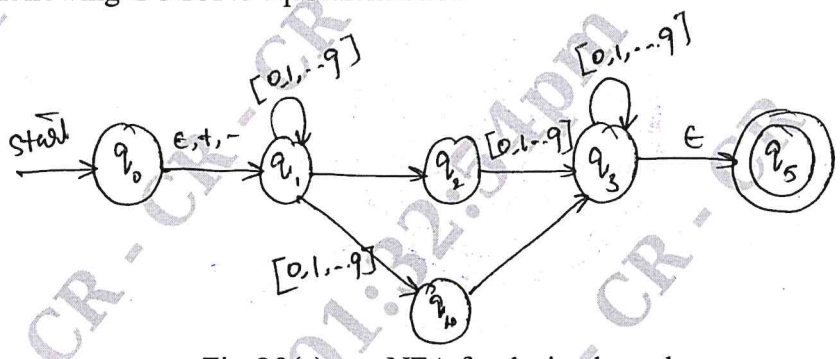

Fig.Q2(a) ∈-NFA for decimal number **(07 Marks)**

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 ∈-NFA. **(03 Marks)**

d. Obtain the regular expression for the following FA using state elimination technique:

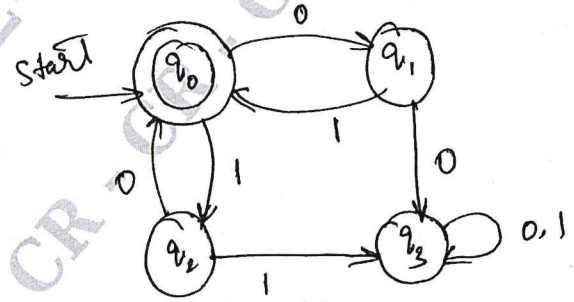

Fig.Q2(d) **(04 Marks)**

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)**

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

δ	a	b
→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)]

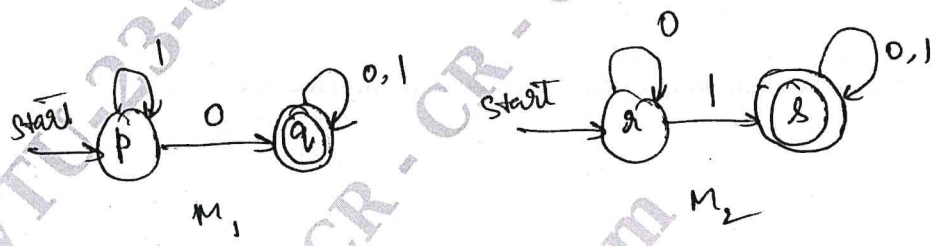

Fig.Q3(d) **(02 Marks)**

4 a. Define a Context-Free Grammar (CFG) and also obtain CFG's for the following languages:
(i) $L = \{0^i 1^j \mid i \neq j, i \geq 0 \text{ and } j \geq 0\}$
(ii) $L = \{(011 + 1)^m (01)^n \mid m, n \geq 0\}$ **(08 Marks)**

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 "abbbba". **(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
$S \rightarrow aAa \mid bBb \mid \in$
$A \rightarrow C \mid a$
$B \rightarrow C \mid b$
$C \rightarrow CDE \mid \in$
$D \rightarrow A \mid B \mid ab$
(i) Eliminate $\in$ - 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.
$S \to AB \mid a$
$A \to aab$
$B \to Ac$ **(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:
a. Application of Regular Expressions
b. Universal Turing Machine
c. Post correspondence problem
d. Recursive language **(20 Marks)**

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