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10CS56

Fifth Semester B.E. Degree Examination, Feb./Mar. 2022
Formal Languages and Automata Theory

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Mention the difference between DFA, NFA and ∈-NFA. **(04 Marks)**

b. Construct a DFA to accept strings over {a, b} such that every block of length five contains atleast two a's. **(05 Marks)**

c. Design a DFA to accept a strings of a's and b's ending with abb. **(05 Marks)**

d. Convert the following NFA to DFA: [Refer Fig.Q.1(d)]. **(06 Marks)**

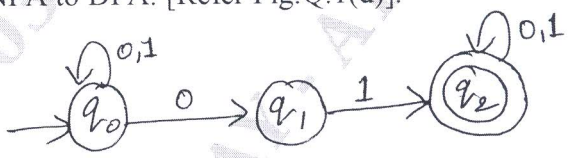

Fig.Q.1(d)

2 a. Consider the following ∈-NFA:

δ	∈	a	b
→ p	{r}	{q}	{p, r}
q	ϕ	{p}	ϕ
*r	{p, q}	{r}	{p}

i) Compute the ∈-closure of each state.

ii) Give the set of all strings of length 3 or less accepted by the automation.

iii) Convert the ∈-NFA to DFA. **(06 Marks)**

b. Prove that, for every regular expression, there exists a finite automation which accepts the same language accepted by the regular expression, ie L(RE) = L(FA). **(05 Marks)**

c. Define regular expression and write regular expression for the following languages:

i) $L = \{a^{2n} b^{2m} : n \geq 0, m \geq 0\}$

ii) Set of all strings not ending with substring 'ab' over $\Sigma = \{a, b\}$. **(06 Marks)**

d. Obtain the regular expression for the following DFA using state elimination technique: [Refer Fig.Q.2(d)]. **(03 Marks)**

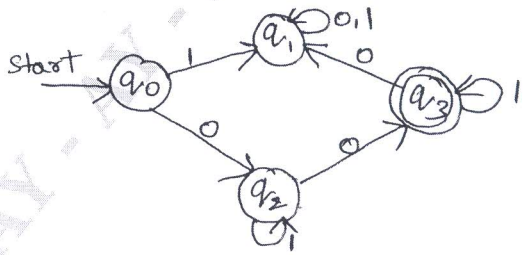

Fig.Q.2(d)

3 a. State and prove pumping lemma of regular languages. And show that $L = \{a^n b^n \mid n \geq 0\}$ is not regular. **(08 Marks)**

b. What is homomorphism? Consider the homomorphism from the alphabet {0, 1, 2} to {a, b} defined by h(0) = ab, h(1) = b and h(2) = aa, then

i) What is h(2201)?

ii) If L is language $(ab + bab)^*bab$. What is $h^{-1}\{L\}$? **(04 Marks)**

c. Minimize the following DFA using table filling algorithm:

δ	0	1
→A	B	A
B	A	C
C	D	B
*D	D	A
E	D	F
F	G	E
G	F	G

(08 Marks)

4 a. Define a CFG and also obtain the CFGs for the following languages:

i) $L = \{0^n 1^n \mid n \geq 1\}$

ii) L = {w : w is a palindrome, where $w \in \{a, b\}^*$}

iii) $L = \{a^n b^m c^k$ where $k = m + n, n, m, k \geq 0\}$

iv) $L = \{w \mid N_a(w) = N_b(w)$ where $w \in \{a, b\}^*\}$ **(08 Marks)**

b. Consider the grammar: $E \rightarrow +EE \mid * EE \mid - EE \mid x \mid y$. Find the Left – Most – Derivation (LMD), Right Most Derivation (RMD) and parse tree for the string "+ * - xyxy". **(06 Marks)**

c. Prove that, the following grammar is ambiguous, using the string "ibtibtaea":

$S \rightarrow iCtS \mid iCtSeS \mid a$

$C \rightarrow b$ **(06 Marks)**

PART – B

5 a. Define PDA. Construct a PDA that accepts the language $L = \{a^n b^n \mid n \geq 1\}$. Write IDs for the string "aaabbb". **(10 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)**

c. Define DPDA (Deterministic) and NPDA (Non-deterministic). **(02 Marks)**

6 a. Consider the following CFG:

$S \rightarrow ABC|BaB$

$A \rightarrow aA|BaC|aaa$

$B \rightarrow bBb|a|D$

$C \rightarrow CA|AC$

$D \rightarrow \in$

i) What is unit production?

ii) Eliminate $\in$-production, unit productions and useless productions from the grammar. **(10 Marks)**

b. What is Chomsky Normal Form (CNF)? Obtain the following grammar in CNF:

$E \rightarrow E + E|E * E|(E)|id$ **(06 Marks)**

c. Show that, $L = \{a^n b^n c^n | n \geq 0\}$ is not context free. **(04 Marks)**

7 a. Design a turing machine to accept the language $L = \{0^n 1^n | n \geq 1\}$. Write its transition diagram. Also show the sequence of moves made by the turing machine for the string "0011". **(12 Marks)**

b. Explain Multi-tap turing machine and non-deterministic turing machines with neat block diagrams. **(08 Marks)**

8 Write short notes on:

a. Post's correspondence problem

b. Recursive languages

c. Applications of finite automata

d. Applications of regular expressions and Context-Free Grammar (CFG). **(20 Marks)**

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