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

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 ϵ -NFA. (04 Marks)
- b. Construct a DFA to accept strings over $\{a, b\}$ such that every block of length five contains at least 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 ϵ -NFA:

δ	ϵ	a	b
$\rightarrow p$	$\{r\}$	$\{q\}$	$\{p, r\}$
q	ϕ	$\{p\}$	ϕ
*r	$\{p, q\}$	$\{r\}$	$\{p\}$

- i) Compute the ϵ -closure of each state.
- ii) Give the set of all strings of length 3 or less accepted by the automation.
- iii) Convert the ϵ -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)

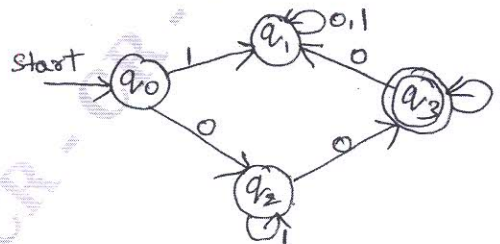


Fig.Q.2(d)

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.

- 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
- What is $h(2201)$?
 - 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
$\rightarrow A$	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:
- $L = \{0^n 1^n \mid n \geq 1\}$
 - $L = \{w \mid w \text{ is a palindrome, where } w \in \{a, b\}^*\}$
 - $L = \{a^n b^m c^k \mid k = m + n, n, m, k \geq 0\}$
 - $L = \{w \mid N_a(w) = N_b(w) \text{ where } w \in \{a, b\}^*\}$ (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:
 $S \rightarrow ABC|BaB$
 $A \rightarrow aA|BaC|aaa$
 $B \rightarrow bBb|a|D$
 $C \rightarrow CA|AC$
 $D \rightarrow \epsilon$
 i) What is unit production?
 ii) Eliminate ϵ -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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