

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-V (NEW) EXAMINATION – WINTER 2023****Subject Code:3151605****Date:07-12-2023****Subject Name:Formal Language and Automata Theory****Time:10:30 AM TO 01:00 PM****Total Marks:70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

MARKS

- Q.1**
- (a) What is Finite Automata? Differentiate DFA vs. NFA. **03**
- (b) Write regular expressions (REs) over alphabet $\{0, 1\}$ **04**
1. Strings start with 0 and has odd length
 2. Strings have odd length
 3. Strings end with 1 and not contain 00
 4. Strings start with 1 and has even length
- (c) Draw Finite Automata for following languages: **07**
1. $L_1 = \{x/x \text{ 00 is not substring of } x, x \in \{0,1\}^*\}$
 2. $L_2 = \{x/x \text{ ends with 01, } x \in \{0,1\}^*\}$
- Draw FA for $L_1 \cup L_2$, $L_1 \cap L_2$ and $L_1 - L_2$
- Q.2**
- (a) Prove that CFG: $S \rightarrow aSbS \mid bSaS \mid \epsilon$ is ambiguous. **03**
- (b) Define Context Free Grammar. **04**
1. Write CFG for regular expression $(a|b)^*a(a|b)^*a(a|b)^*$
 2. Write CFG for equal no. of 'a' and 'b'
- (c) Use the pumping lemma to show that following language is not Context Free: $L = \{a^n b^n c^n | n \geq 0\}$ **07**

OR

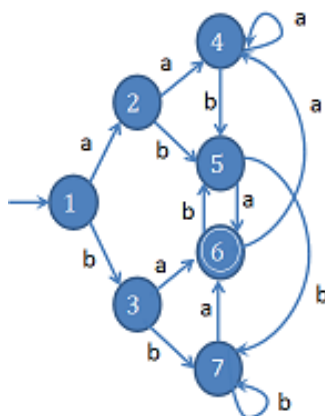
- (c) Design PDA for palindrome with middle symbol 'c'. **07**
- Q.3**
- (a) Design FAs with $\Sigma = \{0, 1\}$ that accept **03**
1. The set of all strings with three consecutive 0's.
 2. The set of all strings those start with '1' and end with '0'.
- (b) Convert given CFG to CNF. **04**
- $S \rightarrow ASB \mid \epsilon$
 $A \rightarrow aAS \mid a$
 $B \rightarrow SbS \mid A \mid bb$
- (c) Convert NFA to FA using subset construction method. **07**

NFA Transition table

q	$\delta(q, a)$	$\delta(q, b)$
1	$\{2, 3\}$	$\{4\}$
2	$\{\phi\}$	$\{4\}$
3	$\{4\}$	$\{3\}$
4	$\{\phi\}$	$\{\phi\}$

OR

- Q.3** (a) Write CFG for balanced parentheses and derive (() ()) 03
 (b) Draw left most derivation tree for string 'aaabbabbba' using CFG 04
 $S \rightarrow aB \mid bA$
 $A \rightarrow aS \mid bAA \mid a$
 $B \rightarrow bS \mid aBB \mid b$
 (c) Minimize given FA 07



- Q.4** (a) Explain classification of grammar as per Chomsky hierarchy. 03
 (b) Draw right most derivation tree for string 'aaabbabbba' using CFG 04
 $S \rightarrow aB \mid bA$
 $A \rightarrow aS \mid bAA \mid a$
 $B \rightarrow bS \mid aBB \mid b$
 (c) Conversion from NFA - Λ to FA 07

q	$\delta(q, \Lambda)$	$\delta(q, 0)$	$\delta(q, 1)$
A	{B}	{A}	ϕ
B	{D}	{C}	ϕ
C	ϕ	ϕ	{B}
D	ϕ	{D}	ϕ

OR

- Q.4** (a) Differentiate Finite Automata vs. Pushdown Automata 03
 (b) Show that the function $f(x,y) = x + y$ is primitive recursive 04
 (c) Given a CFG, $G = (\{S, A, B\}, \{0,1\}, P, S)$ with P as follows: 07
 $S \rightarrow 0B \mid 1A$
 $A \rightarrow 0S \mid 1AA \mid 0$
 $B \rightarrow 1S \mid 0BB \mid 1$
 Convert it into equivalent PDA.
Q.5 (a) What operations are performed by Turing machine? 03
 (b) Explain the halting problem in brief. 04
 (c) Design a Turing machine for accepting ($a^n b^n c^n \mid n \geq 0$) 07

OR

- Q.5** (a) Differentiate recursive language vs. recursively enumerable language 03
 (b) Explain Post's Correspondence Problem (PCP) in brief. 04
 (c) Design a Turing machine for copy a string. 07
