Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI(NEW) EXAMINATION – WINTER 2022

Subject Code:2160704 Date:15-12-2022

Subject Name:Theory of Computation

Time:02:30 PM TO 05:00 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 are the closure properties of regular languages?	**03**
	(b)	Explain reflexivity, symmetry, and transitivity properties of relations.	**04**
	(c)	Using principle of Mathematical Induction, prove that for every n >= 1, $7 + 13 + 19 + \ldots + (6n + 1) = n(3n + 4)$	**07**
Q.2	**(a)**	Derive the string "aabbababbaa" using leftmost derivation for the following grammar. S → aA | bC | b A → aS | bB B → aC | bA | a C → aB | bS	**03**
	(b)	Write Regular Expressions for following (i) The language of all strings in {0,1}* that do not end with 11. (ii) The language of all strings containing both 101 and 010 as substrings.	**04**
	(c)	Consider the NFA-Λ depicted in following table	**07**

	Λ	a	b	c
→p	Φ	{p}	{q}	{r}
q	{p}	{q}	{r}	Φ
*r	{q}	{r}	Φ	{p}

(i) Compute the Λ-closure of each state.
(ii) Convert the NFA-Λ to a DFA.

OR

	(c)	Draw FA for following languages: • L1 = {w | 00 is not substring of w} • L2 = {w | w ends in 01} Find FA accepting languages (i)L1 U L2 and (ii)L1 ∩ L2	**07**
Q.3	**(a)**	Define Bounded Minimalization.	**03**
	(b)	Find the CFG for the regular expression : $(011+1)^*(01)^*$	**04**
	(c)	Convert the following CFG into CNF. S → bA | aB A → bAA | aS | a B → aBB | bS | b	**07**

OR

Q.3 **(a)** Define Primitive Recursive Functions. **03**

(b) Prove that following CFG is Ambiguous. **04**

$S \rightarrow S + S \mid S * S \mid (S) \mid a$

(c) Find CFG for following language: **07**

$L = \{ 0^i 1^j 0^k / j > i + k \}$

Q.4 **(a)** Define Pushdown Automata. **03**

(b) Construct a PDA equivalent to the following CFG. **04**

$S \rightarrow 0BB$

$B \rightarrow 0S \mid 1S \mid 0$

(c) Design the pushdown automata for language $\{0^n1^n | n \geq 0\}$. **07**

OR

Q.4 **(a)** Suppose the PDA $M = (\{q_0, q_1\}, \{a, b, c\}, \{a, b, Z_0\}, \delta, q_0, Z_0, \{q_1\})$ has the following transition function. **03**

1. $\delta(q_0, a, \Lambda) = (q_0, a)$
2. $\delta(q_0, b, \Lambda) = (q_0, b)$
3. $\delta(q_0, c, \Lambda) = (q_1, \Lambda)$
4. $\delta(q_1, a, a) = (q_1, \Lambda)$
5. $\delta(q_1, b, b) = (q_1, \Lambda)$

Show the acceptance of abbcbba by the above PDA.

(b) Prove that $L = \{a^n b^n c^n \mid n \geq 1\}$ is not a CFL. **04**

(c) Design deterministic PDA accepting strings with more a's than b's. **07**

Q.5 **(a)** Enlist limitations of Turing machines. **03**

(b) Write a short note on Halting problem. **04**

(c) Design a Turing machine to reverse the string over alphabet {0, 1}. **07**

OR

Q.5 **(a)** Discuss Universal Turing Machine. **03**

(b) Write a short note on Church-Turing Thesis. **04**

(c) Draw a transition diagram for a Turing machine for the language of all palindromes over {a, b}. **07**

****