Seat No.: ________ Enrolment No.___________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI (NEW) EXAMINATION – SUMMER 2023

Subject Code:3160704 Date:04-07-2023

Subject Name:Theory of Computation

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)**	Let f be a function from the set $A = \{1,2,3,4\}$ to $B = \{p,\ q, r, s\}$ such that, $f = \{(1,p)(2,p)(3,q)(4,s)\}$. Is f^{-1} a function?	**03**
	(b)	L is defined recursively as follows: 1. $\epsilon \in L$ 2. $\forall x \in L$, both $0x$ and $0x1$ are in L. Prove that: For every $n >= 0$, every x belongs to L obtained by n applications of rule 2 is an element of L.	**04**
	(c)	Discuss "Distinguishability" of one string from another and explain how it affects the number of states in an FA. Considering the example of $L = \{a,b\}^*\{aba\}$, how do the distinguishable strings in L relate to the number of states in its FA?	**07**
Q.2	**(a)**	Define: Grammar.	**03**
	(b)	What are similarities and differences between Moore machines and Mealy machines?	**04**
	(c)	Given two languages L_1 and L_2, defined as: $L_1 = \{x \mid all\ x\ start\ with\ aba\}$ $L_2 = \{x \mid all\ x\ ends\ in\ bb\}$ Write the regular expression for both the languages and construct FAs M_1 and M_2 such that M_1 accepts L_1 and M_2 accepts L_2. Derive $L_1 \cap L_2$.	**07**
		OR	
	(c)	Draw the given NFA in Table-1 and convert it to FA and identify the language. q0 is the initial state and q1 is the accepting state.	**07**
Q.3	**(a)**	Draw NFA lambda for the given regular expression: (0)* (00 + 11)* (001) (01 + 10)	**03**
	(b)	Explain the Pumping Lemma for Context Free Languages.	**04**
	(c)	Convert the following grammar to CNF. S → ABA A → aA | ϵ B → bB | ϵ	**07**
		OR	
Q.3	**(a)**	Find the Λ-closure of a set of states for each state of the given NFA lambda in Figure-1.	**03**
	(b)	What are non-CFLs? Give at-least two examples of non-CFLs.	**04**
	(c)	Show Bottom Up Parsing of the string "id + id * id" using the following grammar. E → E + T | T T → T * F | F	**07**

F → (E) | id

Q.4 **(a)** Define PDA. State whether a PDA can accept a CFL or not. **03**

(b) Discuss the closure properties of CFLs. **04**

(c) For the given Turing Machine in Table-2, trace the transition for the strings 1011 and 10101 and identify the language recognized by this TM. TM is defined as TM = (Q, Σ, Γ, q_0, δ) where {q_0,q_1,q_2,q_3,q_4,q_5,q_6} ∈ Q, Σ = {0,1}, {0,1,X,Y,B} ∈ Γ, q_0 ∈ Q, B ∈ Γ , B ∉ Σ, {q_6} is the accepting state. **07**

OR

Q.4 **(a)** Compare NPDA with DPDA. **03**

(b) Show that if there are strings x and y in the language L so that x is a prefix of y and $x \neq y$, then no DPDA can accept L by empty stack. **04**

(c) Draw a TM for the Language of strings with balanced parenthesis “(” and “)” only. **07**

Q.5 **(a)** When can we say that the language is decidable or undecidable? **03**

(b) Draw only the transition table of Turing Machine to accept the language $L = \{0^n 1^n : where\ n \geq 1\}$ **04**

(c) Define: Bounded Minimalization and show that, if P is a primitive recursive $(n+1)$ place predicate, its bounded minimalization mP is a primitive recursive function. **07**

OR

Q.5 **(a)** When can the language be called a recursive language or a recursively enumerable language? **03**

(b) Show that a Turing Machine to recognize the language $L = L(0^*1)$ can accept the string without moving the head in L direction. **04**

(c) Define: μ-Recursive functions and show how all computable functions are μ -recursive. **07**

Table-1

	$\delta(q,0)$	$\delta(q,1)$
q_0	$\{q_0, q_1\}$	$\{q_1\}$
q_1	$\{\emptyset\}$	$\{q_0, q_1\}$

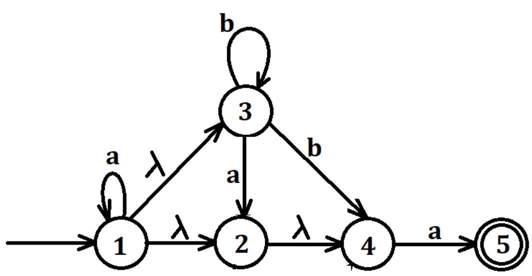

Figure-1

Table-2

State	0	1	X	Y	B
q_0	$(q1, X, R)$	$(q2, Y, R)$	$(q6, X, R)$	$(q6, Y, R)$	$(q6, B, R)$
q_1	$(q1, 0, R)$	$(q1, 1, R)$	$(q3, X, L)$	$(q3, Y, L)$	$(q3, B, L)$
q_2	$(q2, 0, R)$	$(q2, 1, R)$	$(q4, X, L)$	$(q4, Y, L)$	$(q4, B, L)$
q_3	$(q5, X, L)$	—	$(q6, X, R)$	$(q6, Y, R)$	—
q_4	—	$(q5, Y, L)$	$(q6, X, R)$	$(q6, Y, R)$	—
q_5	$(q5, 0, L)$	$(q5, 1, L)$	$(q0, X, R)$	$(q0, Y, R)$	—

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