Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI EXAMINATION – SUMMER 2025

Subject Code: 3160704 **Date: 20-05-2025**

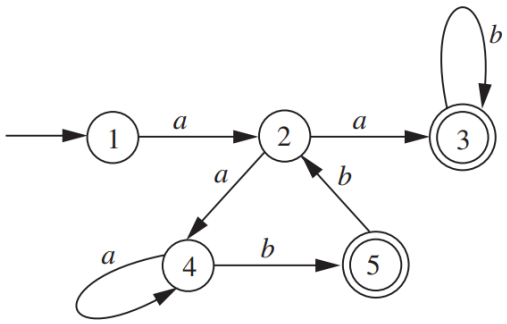
Subject Name: Theory of Computation

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.**

			M
Q.1	**(a)**	Differentiate between constructive proofs and proofs using contradiction with examples.	**03**
	(b)	Write the Strong Principle of Mathematical Induction and prove that for any integer $n \geq 2$, n is either a prime or a product of two or more primes.	**04**
	(c)	Explain the importance of distinguishable strings and equivalent classes' w.r.t. regular languages.	**07**
Q.2	**(a)**	Define Pushdown Automata.	**03**
	(b)	Explain the idea of Finite State Machines with examples.	**04**
	(c)	Apply the subset construction technique and draw the FA accepting the same language represented by given NFA.	**07**



OR

	(c)	Convert the given regular expression to its equivalent NFA-λ. $r = 1 + (101)^* 0 + 01 (01)^* + 11(101)^* + 00(11)^*$	**07**
Q.3	**(a)**	Construct a Finite Automata that accepts all strings over $\{0,1\}^*$ NOT containing the sub-string 101.	**03**
	(b)	Show what languages are generate by the given context free grammar in each case.	**04**

1. $S \rightarrow aSb \mid bSa \mid$
2. $S \rightarrow SS \mid bS \mid a\,\lambda$

	(c)	Construct the CFG for the language $L = \{x \in \{0,1\}^* \mid n_0(x) \neq n_1(x)\}$.	**07**

OR

Q.3 **(a)** Show that the language *pal* of palindrome is not regular. **03**

(b) Find CFG generating the language of even-length strings in $\{a, b\}^*$ with the two middle symbols equal. **04**

(c) Apply the rules and show step by step conversion of the following grammar to CNF. **07**

$S \rightarrow ABCBCDA$
$A \rightarrow CD$
$B \rightarrow Cb$
$C \rightarrow a \mid \lambda$
$D \rightarrow bD \mid \lambda$

Q.4 **(a)** Explain the pumping lemma for context free languages. **03**

(b) Explain unambiguous grammar with an example of converting ambiguous grammar to unambiguous. **04**

(c) Apply the rules and step by step create a Turing Machine to accept $\{a, b\}^*\{aba\}$ **07**

OR

Q.4 **(a)** Explain Ogden's Lemma. **03**

(b) Discuss the decision problems involving CFL. **04**

(c) Construct a Turing machine to accept the strings $x.x^{rev}$ **07**

Q.5 **(a)** Explain the halting problem? **03**

(b) Discuss the Chomsky hierarchy. **04**

(c) Define and explain the working of Turing Machines. **07**

OR

Q.5 **(a)** Explain the difference between decidability and acceptability of a language with respect to TM? **03**

(b) Explain Context-Sensitive Grammars and give example of a context-sensitive language. **04**

(c) Discuss the summary of Church – Turing thesis. **07**

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Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI (NEW) EXAMINATION – SUMMER 2024

Subject Code:3160704 Date:15-05-2024

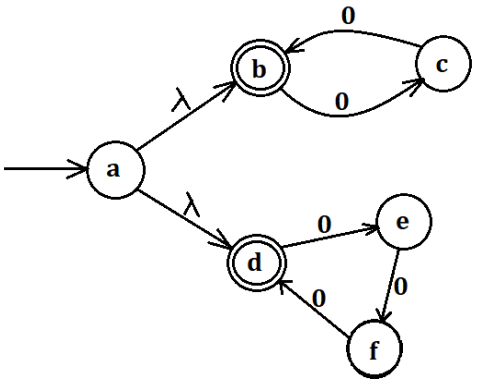
Subject Name:Theory of Computation

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)**	Suppose A and B are sets, $f = A \rightarrow B$ and $g = B \rightarrow A$. If $f(g(y)) = y$ for every $y \in B$, then f is a _____ function and g is a _____ function. Give reasons for your answers.	**03**
	(b)	Given three statements p, q and r. $p: a = 1, q: b = 0, r: c = 3$. *Write the following statements symbolically, using* $p, q, r, \vee, \wedge, \neg$ *and* $\rightarrow$ *only.* 1. Either $a = 1$ or $b \neq 0$. 2. $b = 0$, but neither $a = 1$ *nor* $c = 3$.	**04**
	(c)	Discuss pumping lemma for regular languages.	**07**
Q.2	**(a)**	Define Chomsky Normal Form of grammar.	**03**
	(b)	Define a Moore machine.	**04**
	(c)	Apply the rules and convert the given NFA-λ to FA.	**07**



OR

	(c)	Draw the NFA-λ for r = (0)11* + (101)* 0 and also construct the equivalent NFA and FA for the same.	**07**
Q.3	**(a)**	Given two languages L_1 and L_2 defined over $\Sigma = \{a, b\}^*$, L_1 accepts palindrome strings and L_2 accepts strings with equal number of 0's and 1's. Which one of these languages is regular? Give reasons.	**03**
	(b)	Show how, if a pushdown automaton recognizes some language, then it is context free.	**04**
	(c)	If a regular expression is given as (001)* (01 + 10). Apply the rules to construct a regular grammar for this language.	**07**

OR

Q.3	**(a)**	Construct a Finite Automata that accepts all strings containing 010 or 111 as sub-string only.	**03**

	(b)	Apply pumping lemma to show that the language $L = \{a^n b^n c^n \mid n \geq 0\}$ is not context free.	**04**
	(c)	Apply the rules and show step by step conversion of the following grammar to CNF. S → ASA | aB A → B | S B → b | ϵ	**07**
Q.4	**(a)**	Define DPDA with clear definition of δ (transition function).	**03**
	(b)	Discuss intersection of CFLs with an example.	**04**
	(c)	Apply the rules and step by step create a Turing Machine to accept $L = \{a^n b^n\}$	**07**
		OR	
Q.4	**(a)**	The language of DPDA is called DCFL. Explain whether this statement is true or false.	**03**
	(b)	Discuss complement of CFLs with an example.	**04**
	(c)	Construct a Turing machine to accept even palindrome over Σ = {a,b}*	**07**
Q.5	**(a)**	Explain the concept of undecidable problems.	**03**
	(b)	Discuss multi-tape Turing machine.	**04**
	(c)	Write a note on Primitive Recursive functions.	**07**
		OR	
Q.5	**(a)**	A language is decidable if and only if some nondeterministic Turing machine decides it. Explain the statement.	**03**
	(b)	Regular languages and CFLs are both decidable and Turing-recognizable. Explain whether true or false.	**04**
	(c)	Define and explain Bounded Quantification.	**07**

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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 $\{q_0,q_1,q_2,q_3,q_4,q_5,q_6\} \in Q$, $\Sigma = \{0,1\}$, $\{0,1,X,Y,B\} \in \Gamma$, $q_0 \in Q$, $B \in \Gamma$, $B \notin \Sigma$, $\{q_6\}$ 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 $L = \{0^n1^n: where\ n \geq 1\}$ **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	$\{\emptyset\}$	$\{q_0,q_1\}$

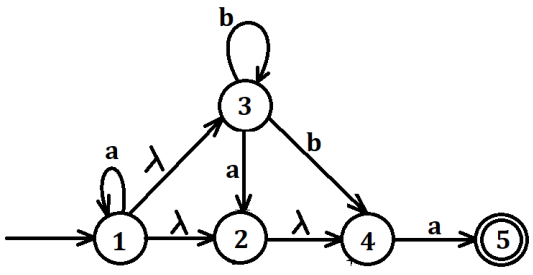

Figure-1

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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Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code:3160704 Date:01/06/2022

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)**	Define: Set, Subset, Complement	**03**
	(b)	Write and explain the principle of mathematical induction using example.	**04**
	(c)	Draw Finite automata for following regular expression: (i). $(0+1)^*(1+00)(0+1)^*$ (ii). $(111+100)^*0$	**07**
Q.2	**(a)**	Explain Regular language & Regular expressions	**03**
	(b)	Find a regular expression corresponding to each of the following subsets of $\{0,1\}^*$ (i). the language of all strings that do not end with 01 (ii). the language of all strings that begin with or end with 00 or 11	**04**
	(c)	Prove Kleene's theorem part-1	**07**
		OR	
	(c)	Explain procedure to minimize finite automata	**07**
Q.3	**(a)**	Define Context free grammar & context free language	**03**
	(b)	Write CFG for following (i) $L=\{a^ib^jc^k \mid i=j \text{ or } j=k\}$ (ii) $L=\{a^ib^jc^k \mid j>i+k\}$	**04**
	(c)	Convert following CFG to CNF : S -> S(S)/^	**07**
		OR	
Q.3	**(a)**	Define Regular grammar and give example.	**03**
	(b)	Explain types of derivation and ambiguity.	**04**
	(c)	Convert following CFG to CNF : S->aX/Yb X->S/^ Y->bY/b	**07**
Q.4	**(a)**	What is a pushdown automaton? Explain.	**03**
	(b)	Give the difference between top down and bottom up parsing.	**04**
	(c)	Design and draw deterministic PDA Accepting "Balance string of brackets"	**07**
		OR	
Q.4	**(a)**	Explain deterministic pushdown automata.	**03**
	(b)	Explain conversion from PDA to CFG.	**04**
	(c)	Design and draw PDA to accept string with more a's than b's.	**07**

Q.5	**(a)**	What is Turing machine? Explain its capabilities.	**03**
	(b)	Explain Church Turing thesis.	**04**
	(c)	Design a Turing machine to copy a string.	**07**
		OR	
Q.5	**(a)**	Explain Primitive Recursive Functions.	**03**
	(b)	Explain Universal Turing machine	**04**
	(c)	Design a Turing machine to delete a symbol.	**07**

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