Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code:3160704 Date:20-11-2024

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)**	Define Finite Automata (FA) with an example.	**3**
	(b)	Write regular expressions for the following. (i) Binary numbers that are multiple of 2. (ii) Strings of a's and b's with no consecutive a's . (iii) Strings of a's and b's containing consecutive a's.	**4**
	(c)	Construct a DFA for the language over {0, 1}* such that it contains “000” as a substring.	**7**
Q.2	**(a)**	Define ε-closure(q) with an example.	**3**
	(b)	State the difference between NFA and DFA.	**4**
	(c)	Prove by pumping lemma, that the language 0^n1^n is not regular.	**7**
		OR	
	(c)	What is ambiguous grammar? Is the following grammar ambiguous? 1. E→ E+E |E*E | id 2. E→ E+E|E*E|(E)|a Justify your answer.	**7**
Q.3	**(a)**	State the definition of Pushdown automata.	**3**
	(b)	Is NPDA (Nondeterministic PDA) and DPDA (Deterministic PDA) equivalent? Illustrate with an example.	**4**
	(c)	Construct PDA for the language $L=\{ww^R \mid w\in(a+b)^*\}$	**7**
		OR	
Q.3	**(a)**	State and prove the pumping lemma for CFL. What is its main application? Give an example.	**3**
	(b)	Compare Deterministic PDA and Non deterministic PDA.	**4**
	(c)	Is it true that non deterministic PDA is more powerful than that of deterministic PDA? Justify your answer.	**7**
Q.4	**(a)**	Construct a CFG for set of strings that contain equal number of a’s and b’s over $\sum = \{a,b\}$.	**3**
	(b)	What is chomsky normal form? Explain with an example	**4**
	(c)	Convert the following grammar G in greibach normal form.	**7**

S→ABb|a
A→aaA|B
B→bAb

OR

Q.4	**(a)**	What is a Turing machine?	**3**
	(b)	Design a Turing machine with no more than three states that accepts the language a(a+b)*. Assume ∑ = {a,b}	**4**
	(c)	Convert the following grammar into CNF S→cBA, S→A, A→cB, A→AbbS, B→aaa	**7**
Q.5	**(a)**	When we say a problem is decidable? Give an example of an undecidable problem.	**3**
	(b)	Mention the difference between P and NP problems.	**4**
	(c)	Prove that for two recursive languages L1 and L2 their union and intersection is recursive.	**7**

OR

Q.5	**(a)**	What is a recursively enumerable language?	**3**
	(b)	Mention the difference between decidable and undecidable problems.	**4**
	(c)	Explain NP-complete problems with an example	**7**

****

Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

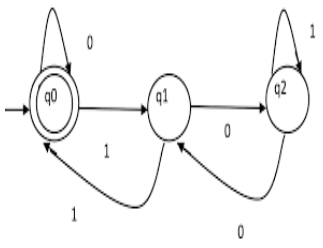
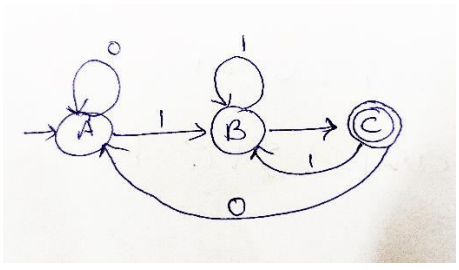
Subject Code:3160704 Date:02-12-2023

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)**	Say whether the statement $(p \wedge (p \rightarrow q)) \rightarrow q$ is tautology or contradiction.	**03**
	(b)	The given relation R on set A= {1,2,3} determine whether the Relation is reflexive, symmetric or transitive, give reason. R ={(1,1), (1,2), (2,1), (2, 2), (3,2),(3,3)}	**04**
	(c)	Write Principle of Mathematical Induction. And prove for every $n \geq 1$, $\sum_{i=1}^{n} \frac{1}{i(i+1)} = n/(n+1)$	**07**
Q.2	**(a)**	Define FA and Write recursive definition of NFA	**03**
	(b)	Find a regular expression of following subsets of {0, 1}* 1. The language of all strings that begin or end with 00 or 11. 2. The language of all strings ending with 1 and not containing 00.	**04**
	(c)	Draw Finite Automata to accept following over input alphabets Σ ={0, 1} (i) The language accepting strings not ending with '01' . (ii)The language accepting strings not containing substring '00'	**07**
		OR	
	(c)	Let M_1 and M_2 be the FAs pictured in Figure, recognizing languages L_1 and L_2 respectively. M1-- M2--   Draw FAs recognizing the following languages. a. $L_1 \cup L_2$ b. $L_1 - L_2$	**07**
Q.3	**(a)**	Find context-free grammar for the language: $L= \{a^i b^j c^k \mid i=j+k\}$	**03**
	(b)	Define mealy machine. Design and mealy machine that gives output 'x' if input of sequence is abb, otherwise z.	**04**
	(c)	Convert NFA- Λ to FA for following figure.	**07**

Q	δ(q, ^)	δ(q, 0)	δ(q, 1)
-A	{B}	{A}	Ø
B	{D}	{C}	Ø
C	Ø	Ø	{B}
+D	Ø	{D}	Ø

OR

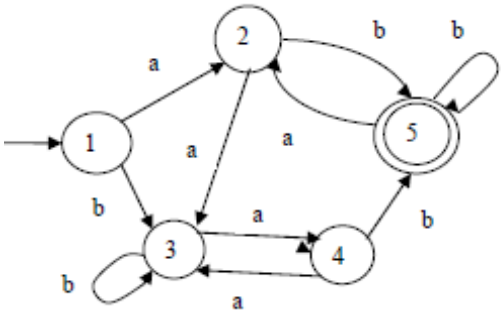
Q.3 **(a)** Define Ambiguous grammar. for following grammar say whether the grammar is ambiguous or not. give reason **03**

S→ABA, A→aA | Λ , B→bB | Λ

(b) Convert the given Moore machine into Mealy machine. Draw state transition diagram of Mealy machine. **04**

Present State	Next State		Output
	0	1	
→p0	r	q0	ε
p1	r	q0	1
q0	p1	s0	0
q1	p1	s0	1
r	q1	p1	0
s0	s1	r	0
s1	s1	r	1

(c) Find minimum state FA for following figure. **07**



Q.4 **(a)** State pumping lemma for context free language. **03**

(b) **04**

Construct PDA for

S → 0AB

A → 1A | 1

B → 0B | 1A | 0

Trace the string 01011 using PDA.

(c) Write Kleen's Theorem part -1. **07**

OR

Q.4 **(a)** Define Push Down Automata **03**

(b) Using kleene's Theorem Draw NFA-Λ for a given RE aa(ba)*+b*aba* **04**

(c) Given the context-free grammar G, find a CFG G' in Chomsky Normal Form. **07**

S -> AaA | CA | BaB

A -> aaBa | DC

B -> bb | aS

C -> Ca | bC | D

D -> bD | Λ

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

(b) Design a PDA to accept L = {xcy | x, y∈ (a,b)* and |x| = |y|}. **04**

(c) Develop a Turing Machine to accept palindromes over {a,b}* **07**

OR

Q.5 **(a)** Define grammar and Chomsky hierarchy. **03**

(b) Design a PDA to accept L = $\{a^i b^j C^k | j = i+k\}$. **04**

(c) Develop a Turing Machine to accept the language L = $\{X / N_a(X)=N_b(X)$, $X \in \{a,b\}^*\}$ **07**

Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code:3160704 Date:13-12-2022

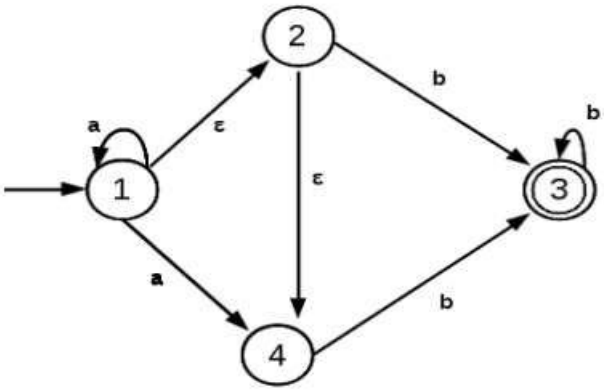
Subject Name:Theory of Computation

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)**	Define the following functions: one-one, on-to, and inverse.	**03**
	(b)	Prove "There must be a prime number between n and n!"	**04**
	(c)	Write down 5-tuple definition for the finite automata. Construct the minimal finite automata over $\Sigma = \{a,b\}$ for the following languages. L1 = {Where all the strings start and ends with different symbol} L2 = {Where every string has odd occurrences of "ba"}	**07**
Q.2	**(a)**	Enlist types of grammars, types of languages and types of automata.	**03**
	(b)	Define pumping lemma for regular language. Show that the language L= $\{a^n b^n c^n / n>=1\}$ is non-regular using pumping lemma theory.	**04**
	(c)	Construct the Moore machine that counts the no. of occurrences of substring "bba" over $\Sigma = \{a,b\}$. Now convert this Moore machine into Mealy machine. Show the transition table and transition diagram for both the machines.	**07**
		OR	
	(c)	Define the steps to convert ε -NFA into NFA. Then convert the following ε -NFA into NFA.	**07**



Q.3	**(a)**	Define type 2 grammar with example.	**03**
	(b)	Construct the regular expressions for the following languages. L1 = {Where the no. of 'a' is odd}, $\Sigma = \{a,b\}$ L2 = {Where every string starts with '0' and of even length}, $\Sigma = \{0,1\}$	**04**
	(c)	What is Instantaneous Description? Construct the pushdown automata over $\Sigma = \{a,b\}$ for the language $L = \{a^n c\, b^n / n>=1\}$.	**07**

OR

Q.3 **(a)** Define the following operations for Push Down Automata: PUSH, POP, and SKIP. **03**

(b) Construct the regular expressions for the following languages. **04**
L1 = {Where every string starts with 'b' and does not contain 2 consecutive a's}, Σ = {a,b}
L2 = {Where every string starts with '1' and of odd length}, Σ = {0,1}

(c) Define: CNF. Show the steps to convert CFG into CNF. Convert the following CFG into equivalent CNF. **07**
$S \rightarrow T\ U$
$T \rightarrow 0T1 \mid \varepsilon$
$U \rightarrow 1U0 \mid \varepsilon$

Q.4 **(a)** Enlist and explain the operations performed by tape in turing machine. **03**

(b) Define pumping lemma for context free language. **04**
Show that the language L= {ww / w ∈{a,b}*} is not context free language using pumping lemma theory.

(c) Explain ambiguous and unambiguous context free grammar with example. **07**

OR

Q.4 **(a)** Enlist closure properties for the context sensitive language. **03**

(b) Discuss universal turing machine with example. **04**

(c) Write down 7-tuple definition for the turing machine. **07**
Construct the turing machine and its transition table over Σ = {a,b} for the language L = $\{a^n b^n / n>=1\}$.

Q.5 **(a)** State the following functions: Partial, Constant and Total. **03**

(b) What is minimization? Explain with suitable example. **04**

(c) Discuss Post's Correspondence Problem with example. **07**

OR

Q.5 **(a)** Define the following terms: Recursive language, and Recursive Enumerable Language. **03**

(b) Explain in detail: Class P and Class NP. **04**

(c) Describe: Recursive function. Prove that every recursive function is computable. **07**

****