VIT
Vellore Institute of Technology

School of Computer Science and Engineering

Winter Semester 2023-24

Continuous Assessment Test – 1

SLOT: B2+TB2

Programme Name &Branch: B.Tech

Course Name & code: BCSE304L Theory of Computation

Class Number (s): VL2023240500760, 0763,0766, 0768, 0771, 0774,0784, 0789, 0797, 0845, 0861, 1014, 1015, 1026,1029, 1036, 1037, 1042,1043, 1045, 1047, 1049,1051

Faculty Name (s): Prof.Sathiya Kumar C, Prof.Anand M,Prof.Arumuga Arun R, Prof.Viswanathan P, Prof.Shalini L, Prof. Kannadasan R,Prof. Krishna Rani Samal K,Prof.Navamani T M, , Prof.Rajarajan G,Prof.Madiajagan M, Prof.Saritha Murali, Prof.Vishnupriya,Prof. Mohana CM,Prof.Krishnaraj N, Prof.Kanagaraj R,Prof.Anand Bihari,Prof. Somasundaram S K, Prof.Hussain Ahmed Chowdhury, Prof. Sarwesh P,Prof. Umamaheswari M, Prof. Konatham Sumalatha Prof. Sabyasachi Kamila, Prof. Uma Priya D

Exam Duration: 90 **Maximum Marks: 50**

Q.No. 1 — **Max Marks: 10**

a) Prove by induction on the following
$(uv)^r = v^r u^r$, where u and v are strings over Σ and r is the reversal operator. (3 Marks)

b) i) Assume $\Sigma = \{a,b,c\}$, then find Σ^2.
ii) Assume $\Sigma = \{0,1\}$, then find Σ^3. (4 Marks)

c) Given L in Σ^*, can both L & L^c (c is a complementary operation) be finite? Justify? (3 Marks)

Q.No. 2 — **Max Marks: 10**

Convert the following NFA with ε to NFA without ε.

	a	B	ε
-> q0	q1	∅	{q0,q2}
q1	q2	q1	q1
*q2	q2	∅	q0

Starting state : q0 Final State : q2

Q.No. 3 — **Max Marks: 10**

a) Construct a DFA that accepts all the strings over Σ = {a,b} whose length is divisible by 6. (5 Marks)

b) Convert the following NFA to DFA.

	0	1
-> q0	{q1,q3}	q1
*q1	q2	{q1,q2}
q2	q3	q0
*q3	∅	q0

Starting state : q0
Final States : {q1,q3} (5 Marks)

4.	i) Minimize the given DFA transition table. Starting state : q0 Final States : {q2,q3,q4} (5Marks) ii) Convert the given Regular Expression into Finite Automata. **((ab)*.(ab+a*b))** (5Marks)	10
5.	Convert the Finite Automata (whose transition table is given below) to the equivalent Regular Expression. Starting state : q0 Final State : q3	10

	A	B
-> q0	q1	q2
q1	q2	q4
*q2	q3	q2
*q3	q4	q4
*q4	q4	q5
q5	q5	q5

	0	1
-> q0	q0	q1
q1	q2	q3
q2	q2	q3
*q3	q2	q3

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Winter Semester 2023-24

Continuous Assessment Test – 1

SLOT: B1+TB1

Programme Name & Branch: B.Tech

Course Name & code: BCSE304L Theory of Computation

Class Number (s): VL2023240500758, 0762, 0764, 0767, 0769, 0770, 0773, 0783, 0788, 0794, 0842, 0859, 1011, 1013, 1024, 1027, 1028, 1031, 1034, 1038, 1040

Faculty Name (s): Prof.Sathiya Kumar C, Prof.Anand M, Prof.Lakshmanan K, Prof.Viswanathan P, Prof.Arumuga Arun R, Prof.Shalini L, Prof. Kannadasan R, Prof.Gunavathi C, Prof.Navamani T M, Prof.Rajarajan G, Prof.Madiajagan M, Prof.Saritha Murali, Prof. Radhakrishnan Delhibabu, Prof.Vishnupriya, Prof.Krishnaraj N, Prof.Bhuvaneswari M, Prof.Kanagaraj R, Prof.Sathya K, Prof.Anand Bihari, Prof.Baskaran P, Prof.Hussain Ahmed Chowdhury

Exam Duration: 90 Min. **Maximum Marks: 50**

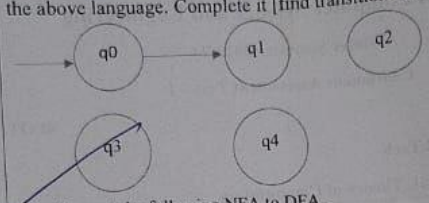
General instruction(s): - Step by Step Procedure is required to solve the Problem

Q.No.	Question	Max Marks
1.	a. Prove using mathematical induction for the following **$\|uv\| = \|u\| + \|v\|$ for u,v are strings over Σ.** *(3 Marks)*	10
	b. Consider A={00,10,20}, $\emptyset$ ={ }, L={ ε } and Σ = {0,1,2}. Then compute the following **1. L^*** **2. $\emptyset^*$** **3. Σ^2-A where – is a setminus operation.** *(4 Marks)*	
	c. Give an example for (i) L & L^c (c is a complementary operation of L) are infinite. *(3 Marks)* (ii) L is finite and L^c is infinite.	
2.	Convert the following NFA with ε to NFA without ε	10

	a	b	c	ε
-> q0	q0	∅	∅	q1
q1	∅	q1	∅	q2
* q2	∅	∅	q2	∅

Starting state : q0
Final State : q2

3. a) Construct a DFA which accepts all strings over the alphabet $\Sigma = \{0,1\}$ which can be seen as a binary representation of numbers that are divisible by 4. For example, number 5 corresponds to the string 101 (which is a binary number representation for 5) and the string 101 should be rejected by the DFA. The following is an incomplete attempt to construct the automata for the above language. Complete it [find transitions and final state(s)].



(5 Marks)

b) Convert the following NFA to DFA.

-> q0	{q0,q1}	q0
q1	q2	q2
*q2	∅	∅

Starting state : q0
Final State : q2

(5 Marks)

10

4. i) Minimize the DFA whose transition table is given below.

	0	1
-> q0	q1	q3
q1	q2	q4
q2	q3	q2
*q3	q4	q5
*q4	q3	q4
*q5	q4	q5

Starting state : q0
Final State : {q3,q4,q5}

(5Marks)

ii) Given a regular expression for the Language that contains **ab** or **ba** in the sting for Σ = {a,b}

(2 Marks)

iii) Convert the following Regular Expression to Finite Automata.

(a*+bc)

(3 Marks)

10

5. Convert the given Finite Automata transition table to Regular Expression.

	a	b
-> q0	q1	q1
q1	q2	{q1,q3}
q2	∅	q3
*q3	q3	∅

Start State: q0
Final State: q3

10

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SCHOOL OF COMPUTER SCIENCE AND ENGINEERING
CONTINUOUS ASSESSMENT TEST - II
WINTER SEMESTER 2023-2024

SLOT: B1 + TB1

Programme Name & Branch	: B.Tech
Course Code	: BCSE304L
Course Name	: Theory of Computation
Faculty Name(s)	: Prof. Sathiyakumar, Prof.Anand M, Prof. Lakshmanan K, Prof. Viswanathan P, Prof. Arumuga Arun R, Prof. Shalini L, Prof. Kannadasan R, Prof. Gunavathi C, Prof. Navamani T M, Prof. Rajarajan G, Prof. Madiajagan M, Prof. Saritha Murali, Prof. Delhibabu R, Prof. Vishnupriya, Prof. Krishnaraj N, Prof. Bhuvaneswari M, Prof. Kanagaraj R, Prof. Sathya K, Prof. Anand Bihari, Prof. Baskaran P, Prof. Hussain Ahmed Chowdhury
Class Number(s)	:VL2023240500758, 0762, 0764, 0767, 0769, 0770, 0773, 0783, 0788, 0794, 0842, 0859, 1011, 1013, 1024, 1027, 1028, 1031, 1034, 1038, 1040
Duration: 90 min.	Max. Marks: 50

Q. No	Question	Marks
1.	a) For languages A and B, let the perfect shuffle of A and B be the language $\{w \mid w = a_1b_1\cdots a_kb_k$, **where** $a_1\cdots a_k \in A$ **and** $b_1\cdots b_k \in B$, **each** $a_i,b_i \in \Sigma\}$. Show that the class of regular languages is closed under perfect shuffle.	5
	b) Prove using pumping lemma, the following language is not regular $L=\{w \in \{0,1\}^* \mid w$ **contains more 0's than 1's**$\}$	5
2.	(a) Design a CFG for the language $L=\{ww^Rzz^R \mid w,z \in \{0,1\}^+$, **011 is a substring of w and** $\lvert z\rvert$ **is odd,** w^R **is the reverse of w,** z^R **is the reverse of z**$\}$. Explain the use of each production in the constructed grammar?	5
	(b) Convert the given Context free grammar G into an equivalent context free grammar G_1 in Chomsky normal form (CNF) $S \rightarrow aXbX$ $X \rightarrow aY \mid bX \mid \lambda$ $Y \rightarrow X \mid e$	5
3.	(a) Show that the language $L = \{\beta\#\beta^R\#\beta \mid$ **where** $\Sigma=\{a,c,\#\}$ **and** $\beta \in \{a,c\}^*\}$ is not context free (β^R is the reverse of β).	5
	(b) Write the above language L (in Question 3(a)) as the intersection of two context-free languages (over Σ).	5

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SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

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WINTER SEMESTER 2023-2024

SLOT: B1 + TB1

4.	Consider the following context free grammar (where A is the start symbol) **A → BA | AC | a** **B → CB | BA | b** **C → AC | CB | a** Apply CYK algorithm for the input string ***abbaa***. Find the nonterminal set where X is marked in the table. Without steps full marks will not be awarded. X X X X X X X a b b a a	10
5.	Give a push down automata (PDA) that recognizes the language L of all strings $w \in \{0,1\}^*$ such that the first and last symbol of w are the same, and moreover, if the length of w is odd, then the middle symbol of w is different from the first and the last. For example, strings 00, 11, 010, 010100010010, 0101010 are in L, but λ, 0, 1, 000, 111, 110, 00001, 1001001 are not. Show the configurations made by the constructed PDA for the input strings **(a) 0101010 (b) 111**	10

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Winter Semester 2023-24

Continuous Assessment Test – II

SLOT: B2+TB2

Programme Name & Branch: B.Tech

Course Name & Code: Theory of Computation & BCSE304L

Class Number (s): VL2023240500789, VL2023240501047, VL2023240501029, VL2023240500774, VL2023240500845, VL2023240500760, VL2023240501015, VL2023240500784, VL2023240501045, VL2023240500861, VL2023240501036, VL2023240500763, VL2023240501026, VL2023240500766, VL2023240500771, VL2023240501043, VL2023240500797, VL2023240501049, VL2023240501037, VL2023240501042, VL2023240501051, VL2023240501014.

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Exam Duration: 90 Min. Maximum Marks: 50

Q. No.	Question	Max Marks
1.	a) The derivative of a language for a string x is defined asfollows: $L_x = \{ y \mid xy \in L\}$. 1) what is L_{aa} for the language $L=\{a^{n+1}b^n \mid n \geq 1\}$. (1mark) 2) what is L_b for the language $L=\{a^{n+1}b^n \mid n \geq 1\}$. (1 mark) 3) Prove that when L is regular, the derivative of L (ie., L_x) isalso regular. (3 marks)	5
	b) Consider the language $L_1=\{a^pb^qa^r \mid pq,r \geq 1$ and $p+q \neq r\}$.Prove or disprove that the language L is regular.	5
2.	a) Design a CFG for the language $Y = \{a^n b^m a^{2n}: n, m \geq 0\}$.	5
	b) Consider the grammar $S \rightarrow 0S1 \mid 1S0 \mid \lambda$, where S is the start symbol, {0,1} are terminals . You can see that for every 0 there is a 1 and vice versa in the rule (other than $S \rightarrow \lambda$). Is the grammar generates the language $L_2 = \{w : \lvert w\rvert_0 = \lvert w\rvert_1\}$ where $\lvert w\rvert_a$ refers to the occurrences of a in w. If not, justify with a string in the language L_2 that cannot be produced by the given grammar rules. What further changes you need to do in the given grammar in order to generate L_2	5
3.	a) Construct the CYK algorithm for the following CFG and check whether the string **"aabcb"** is derivable from the grammar. The Start Symbol is A.	10

	$A \rightarrow CB$ $B \rightarrow DC \mid b$ $C \rightarrow BD \mid a$ $D \rightarrow AD \mid c$	
	a) Construct the given Context Free Grammar **G=(V,T,P,S)** into Chomsky normal form. P is the start symbol. $P \rightarrow RPT$ $Q \rightarrow RP/Ra$ $R \rightarrow bRPR \mid b \mid \varepsilon$ $T \rightarrow PaP \mid R \mid aa$	5
	b) Derive the CFG for the given Context Free Language $L = \{v^r i^{r+s} t^s \mid r, s \geq 0\}$ and check the ambiguity of the givengrammar.	5
	The language L have a strings of balanced "#" symbol and "@" symbol : every "#" symbol can be paired with a unique subsequent of "@" symbol , and every "@" symbol can be paired with a unique preceding "#" symbol. Moreover, the string between any such pair has the same property. Derive the language for the given condition and Construct the PDA for the derived language.	10