Reg. No.														

B.Tech. DEGREE EXAMINATION, JUNE 2023

OPEN BOOK EXAMINATION

Fifth Semester

18CSC301T – FORMAL LANGUAGE AND AUTOMATA

(For the candidates admitted during the academic year 2018-2019 to 2021-2022)

- Specific approved THREE text books (Printed or photocopy) recommended for the course
- Handwritten class notes (certified by the faculty handling the course / Head of the Department)

Time: 3 Hours Max. Marks: 100

Answer **FIVE** questions

(Question: No 3 is compulsory)

		Marks	BL	CO	PO
1.i.	Consider the following ϵ–NFA. Compute the ϵ–closure of each state and find its equivalent DFA.	12	4	1	2

δ	ε	a	b	C
→ p	ϕ	{p}	{q}	{r}
q	{p}	{q}	{r}	ϕ
*r	{q}	{r}	ϕ	{p}

ii.	Prove that if L is a regular language over the alphabet ∑, then its complement $\bar{L} = \Sigma^* - L$ is also regular with Example.	6	2	1	2
iii.	Finite Automata requires minimum ___ number of stacks (A) 1 (B) 0 (C) 2 (D) Infinite	1	1	1	1
iv.	Number of states requird to accept string ends with 10 _____. (A) 3 (B) 4 (C) 5 (D) 6	1	1	1	1
2.i.	Solve the NFA that accepts all strings that ends in 01. Give its transition table and the extended transition function for the input string 0101. Also construct a DFA for the above NFA using subset construction method.	12	4	1	4
ii.	Deduce a DFA that accept the following language: {x ϵ {a,b} : |xa |= Odd and |xb| = Even}	6	4	1	4
iii.	Which pair is equivalent regular expression? (i) (ab)* and a*b* (ii) a(aa)* and (aa)*a (iii) a+ and a*a (A) Only (i) (B) Only (ii) (C) (ii) and (iii) (D) (i)(ii) and (iii)	1	1	1	1
iv.	How many DFA's exist with two states over input alphabet {0,1}? (A) 16 (B) 26 (C) 32 (D) 64	1	1	1	1

3.i. Design and Explain the following grammar into equivalent one with no unit production and no useless symbols and convert into CNF. 12 5 2 4

S->A|CB
A->C|D
B->1B|1
C->0C|0
D->2D|2

ii. From the output of previous part convert that Chomskey normal form (CNF) to Greihback Normal Form (GNF). 6 4 2 4

iii. Which of the following statement is false? 1 1 2 1

(A) A recursive language is also a regular language
(B) A context free language is also a regular language
(C) A context free language is also recursive enumerable language
(D) Both (A) and (B)

iv. A context free grammar G is in Chomsky normal form if every production is of the form 1 1 2 1

(A) A->BC or A->A
(B) A->BC or A->a
(C) A->BCa or B-> b
(D) A->B or B->a

4.i. A company organized an annual celebration event for all its employees. The employees participated in various games of the events. One such game is picking the ball from the pool. The employee has to pick the balls in the order specified. The one who is picking all the balls in the specified order at the earliest is the winner. The coloured balls are Red, Green, Violet, Yellow. 12 5 3 4

Case (i):

First, they should pick 'n' number of red balls then 'm' number of green balls then 'n' number of Violet balls and at last 'p' number of yellow balls.

Case (ii):

Or else, first they should pick 'n' number of red balls then 'm' number of green balls then '2n' number of Violet balls and at last 'p' number of yellow balls.

The order should not vary. Design a single Push Down Automata to check the order and constraints of the game satisfying both the cases. Explain the designed PDA with example strings.

ii. Show that L={ww/wϵ {a,b}*} is not context free. 6 5 3 4

iii. Statement: L= {1^n|n is a square} is not regular 1 1 3 1

(A) True
(B) False
(C) Either true or false
(D) Neither true or false

iv. The notation used in Instantaneous Description is 1 1 3 1

(A) Alpha
(B) Turnstile
(C) Turn
(D) Beta

5.i. Design a Turing Machine for adding two numbers. 12 5 4 4

ii. Explain the different variants of Turing Machine and its capabilities. 6 3 4 3

iii. Turing Machine is otherwise known as _____. 1 1 4 1

(A) Recursive Language
(B) Enumerable Language
(C) Adaptable Language
(D) Recursively Enumerable Language

iv. _____ is a special symbol in seven tuple representation of Turing Machine. 1 1 4 1

(A) Q
(B) F
(C) Σ
(D) B

6. An UPI based online payment application wishes to attract new customers. In this perspective, it has decided to give a reward of Rs 5 for every transaction made to the sender as well as the receiver of the amount.

i. Construct a TM transition rules that calculates the total amount of the receiver (including reward). 8 5 4 4

ii. Draw the transition diagram and table for the same. 6 3 4 4

iii. Compute the total amount at the receiver if the actual transaction is Rs 6. Illustrate it using instantaneous description. 4 4 4 4

iv. The Turing machines are brain child of _____. 1 1 4 1

(A) Programming languages
(B) Microprocessors
(C) Stored program concept
(D) Microcontrollers

v. If MPCP can be solved then PCP can also be solved. Which property illustrates this? 1 1 4 1

(A) Computational complexity
(B) Decidability
(C) Reducibility
(D) Computability

7. Every year a common festival is celebrated between two villages A and B. On account of this, a local sport is organized by the villagers. The selection of players in this year happens according to the given table (Here 0 indicates women and 1 indicates men). The positioning of the players is made in such a way that at any position, if village A places a set of players from set i, then village B should also place the set of players from set i only. This pattern will repeat for other sets also.

i	A	B
1	11	10110
2	111	000
3	001	0101
4	010	0

i. The audience claim that there are at least two ways in which the men and women of villages A and B can be placed after fulfilling the condition of the game. Is this true? If yes, give the sequence. 10 3 5 3

ii. Assuming the above given table is a MPCP problem, convert it into PCP. 4 3 5 3

iii. Construct a TM, for another game in which if village A places men then village B should place woman and vice versa. Design a TM to help village B in doing so. 4 3 5 3

iv. Consider the statements: 1 1 5 1

S1: All recursively enumerable languages are countable.

S2:Set of all non-regular languages over the alphabet {a,b,c} is recursively enumerable.

(A) Both are true (B) Only S1 is true

(C) Only S2 is true (D) Both are false

v. A NP complete problem is the conjunction of_____. 1 1 5 1

(A) NP hard and NP (B) NP and P

(C) NP hard and P (D) NP hard alone

* * * * *

June - 2023 Qn 7 : Village Festival

(i) PCP

	Num	Deno
i	A	B
1	11	10110
2	111	000
3	001	0101
4	010	0

$i=1$: 11 / 10110 — $i=2$: 111 / 000

$i=3$: 001 / 0101 — $i=4$: 010 / 0

Sequence (1) $i=4 \to 1 \to 3 \to 4$

A → 0 1 0 1 1 0 0 1 0 1 0

B → 0 1 0 1 1 0 0 1 0 1 0

∴ Strings A and B match for the sequence when $i = 4 \to 1 \to 3 \to 4$

Sequence (2)

A → 0 1 0 1 1 0 0 1 0 1 0

B → 0 1 0 1 1 0 0 1 0 1 0

* Cannot start with $i = 1, 2$ or 3
* Second tile cannot start with '0', ∴ $i = 1$ is the only option

∴ Only one sequence $i = 4 \to 1 \to 3 \to 4$ is possible. Second sequence is not possible.

(ii) Converting MPCP into PCP

Step 1: Add * after each symbol in string A
Add * before each symbol in string B

A	B
1*1*	*1*0*1*0
1*1*1*	*0*0*0
0*0*1*	*0*1*0*1
0*1*0*	*0

Step 2: Add $ and *$ in strings A and B respectively

A	B
1*1*	*1*0*1*0
1*1*1*	*0*0*0
0*0*1*	*0*1*0*1
0*1*0*	*0
$	*$

Step 3: Repeat first pair with string A prepended with *

A	B	
$*1*1*$	$*1*0*1*0$	start
$1*1*$	$*1*0*1*0$	
$1*1*1*$	$*0*0*0$	
$0*0*1*$	$*0*1*0*1$	
$0*1*0*$	$*0$	
$\$$	$*S$	Ends

MPCP converted to PCP

(iii) Constructing TM

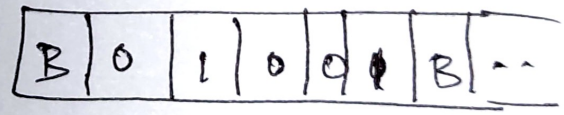
0 – woman 1 – man

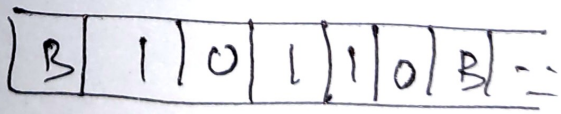
Let $w = 01001$

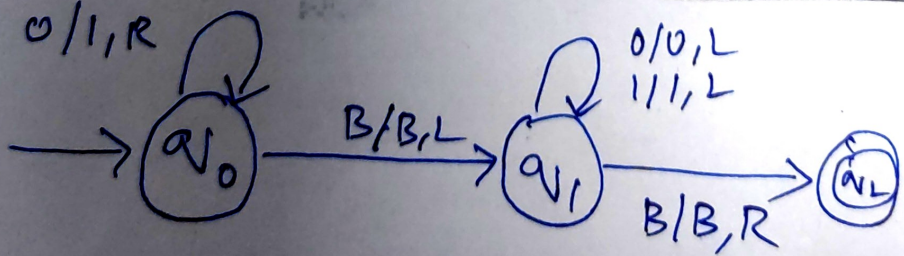
$w' = 10110$

A → 0 1

B → 1 0



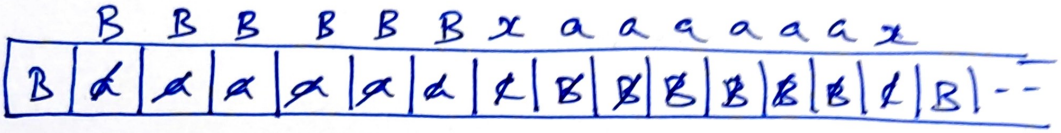




June - 2023 Qn.6 : UPI based Online Payment

(i) Construct a TM transition rules that calculates the total amount of the receiver (including reward)

Soln :

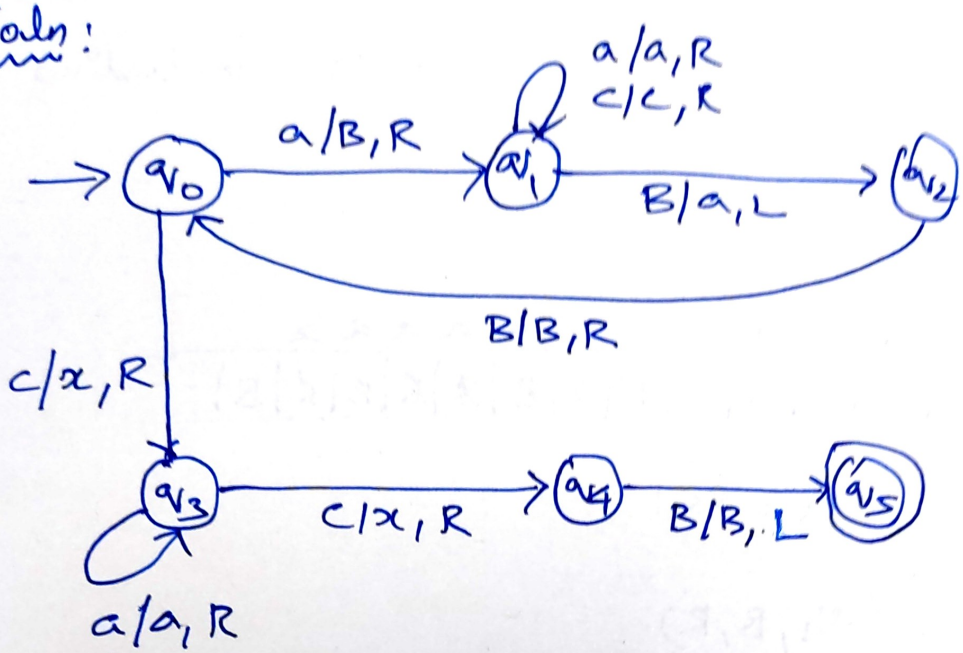


Let x = Rs.5, a = Rs.1

1. $\delta(q_0, a) = (q_1, B, R)$
2. $\delta(q_1, a) = (q_1, a, R)$
3. $\delta(q_1, C) = (q_1, C, R)$
4. $\delta(q_1, B) = (q_2, a, L)$
5. $\delta(q_2, a) = (q_2, a, L)$
6. $\delta(q_2, C) = (q_2, C, L)$
7. $\delta(q_2, B) = (q_0, B, R)$
8. $\delta(q_0, C) = (q_3, x, R)$
9. $\delta(q_3, a) = (q_3, a, R)$
10. $\delta(q_3, C) = (q_4, x, R)$
11. $\delta(q_4, B) = (q_5, B, L)$

(ii) Draw the transition diagram and table for the same.

Soln:



Transition Table

Current state	Tape Symbols		
	a	B	c
q_0	(q_1, B, R)		(q_3, x, R)
q_1	(q_1, a, R)	(q_2, a, L)	(q_1, c, R)
q_2	(q_2, a, L)	(q_0, B, R)	(q_2, c, L)
q_3	(q_3, a, R)		(q_4, x, R)
q_4		(q_5, B, L)	
q_5			