National University of Computer and Emerging Sciences

Lahore Campus

Theory of Automata (CS3005)

Date: May 30th 2024

Course Instructor(s)

Mr. Fraz Yousaf

Final Exam

Total Time (Hrs):	**3**
Total Marks:	**65**
Total Questions:	**4**

Roll No _____ Student Signature _____

Do not write below this line.

Attempt all the questions.

CLO #1: Identify formal language classes and prove language membership properties.

Question :1 **[3 + 2 + 8]**

a) If L1, L2 and L3 are Regular languages and L4 = L1 ∩ (L2 ∪ L3). What kind of language will be L4. (RL, CFL or non-CFL) Explain briefly.

b) **True/ False** Can a DFA recognize a palindrome number?

c) *Tell whether the following Language is context free (CFL) or non- context free (non- CFL). If it is CFL provide PDA else prove it using Pumping Lemma.*

$$L = \{x \in \{a, b, c\}^* \mid n_a(x) < n_b(x) \text{ and } n_a(x) < n_c(x)\}$$

CLO #2: Differentiate and manipulate formal descriptions of languages, automata and grammars with focus on non-regular and regular using automata (DFA, NFA, NFA-Null)

Question: 2 **[2 + 7.5 + 7.5]**

a) Which of the following is true?

a) (01)*0 = 0(10)*

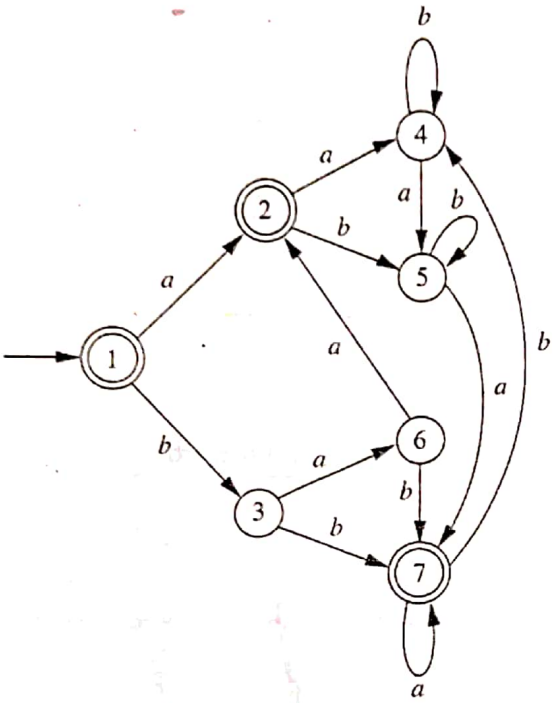
b) (0+1)*0(0+1)*1(0+1) = (0+1)*01(0+1)*

c) (0+1)*01(0+1)*+1*0* = (0+1)*

d) All of the mentioned

b) Minimization of DFA

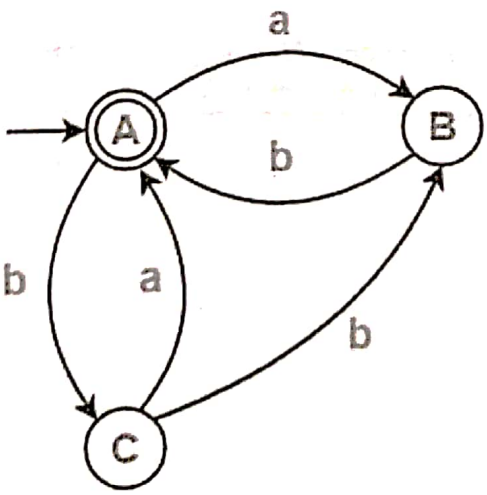
Find a minimum-state DFA recognizing the same language. Show complete working. Use only the method discussed in your respective class.



	a	b
1	2	3
2	4	5
3	6	7
4	5	4
5	7	5
6	2	7
7	7	4

c) State Elimination Method

Use the State Elimination Method for extraction of Regular Expression. Write Final Regular Expression. Delete the states in increasing order of alphabets[First A then B then C]



CLO #3: Differentiate and manipulate formal descriptions of languages, automata, and grammars. with focus on context-free languages using automata (PDA and NPDA).

Question 3: [3 +5 +12 + 5]

a) Tell whether the following grammar is ambiguous. How? Give justification.

S → A | B
A → aAb | ab
B → abB | ∈

b) Give a context-free Grammar for the regular expression $0^* 1(0+1)^*$

c) Dry run the single-tape Turing machine on next page and give the content of the tape after running it (When TM halts).

The initial configuration of the TM is given below.

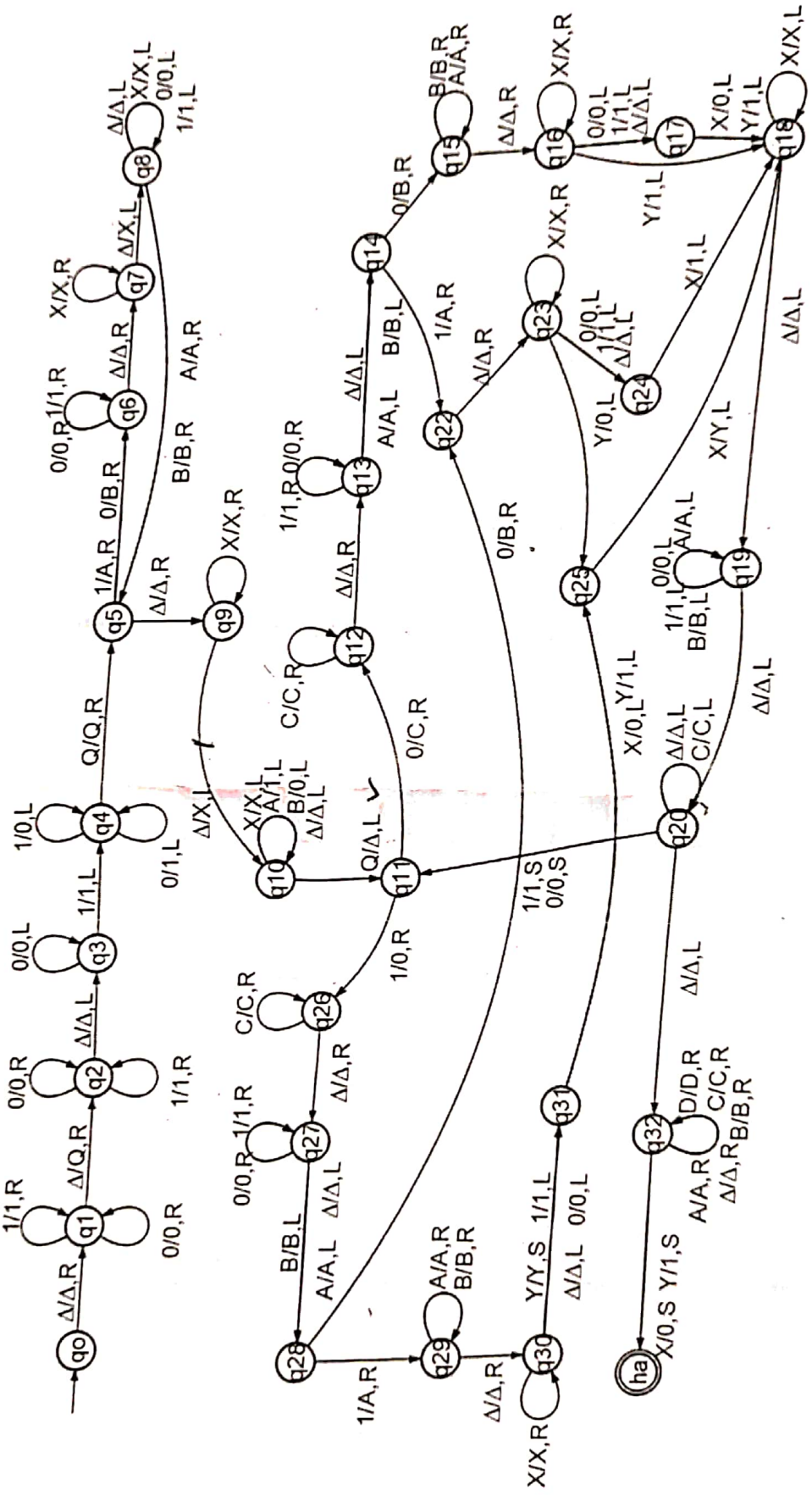
Δ	1	1	1	1	Δ	0	1	1	1	Δ	Δ	.....	Δ

head/pointer

Answer: You need to answer on the Answer Sheet.

Δ	Δ	0																

Clearly show where will be the head/pointer when TM halts


q0
q1
q2
q3
q4
q5
q6
q7
q8
q9
q10
q11
q12
q13
q14
q15
q16
q17
q18
q19
q20
q22
q23
q24
q25
q26
q27
q28
q29
q30
q31
q32
ha
Δ/Δ,R
0/0,R
1/1,R
Δ/Q,R
Δ/Δ,L
0/0,L
1/1,L
1/0,L
0/1,L
Q/Q,R
0/B,R
1/A,R
B/B,R
A/A,R
Δ/X,L
X/X,R
Δ/Δ,R
X/X,L
0/0,L
1/1,L
Δ/X,L
Q/Δ,L
X/X,L
A/1,L
B/0,L
Δ/Δ,L
C/C,R
0/C,R
1/1,R
0/0,R
Δ/Δ,R
B/B,L
A/A,L
Δ/Δ,L
0/B,R
A/A,R
B/B,R
1/A,R
X/X,R
0/0,L
1/1,L
Δ/Δ,L
X/0,L
Y/1,L
X/1,L
Y/0,L
X/Y,L
Δ/Δ,L
1/1,S
0/0,S
Y/Y,S
1/1,L
Δ/Δ,L
0/0,L
X/0,S
Y/1,S
D/D,R
C/C,R
B/B,R
A/A,R
Δ/Δ,R

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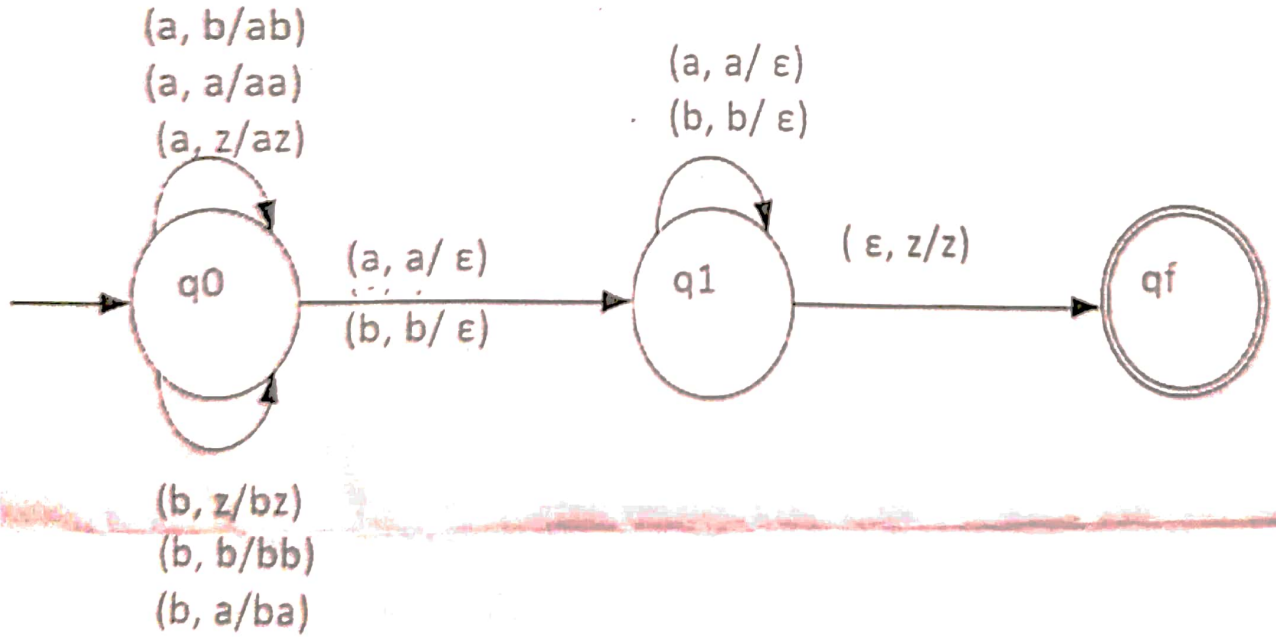
d) Initially, the stack contains the symbol "z". Design the parse tree for the string "aabbaa" using a non-deterministic pushdown automaton (NPDA), following the pattern discussed in class



CLO #4: Differentiate and manipulate formal descriptions of languages, automata and grammars with focus on non context-free languages using Turing Machines

Question: 4 **[10]**

Design a single-tape Turing machine to reverse the elements on the tape. Your machine has limited memory, NOT allowing you to replace any blank symbol with another symbol. You can modify each cell at most twice, ensuring all changes occur on the tape itself, except for blank symbols.

Sample Input 1:

Δ	1	1	1	0	1	0	Δ

Sample Output 1:

Δ	0	1	0	1	1	1	Δ

Sample Input 2:

Δ	0	0	0	1	1	1	Δ

Sample Output 2:

Δ	1	1	1	0	0	0	Δ