National University of Computer and Emerging Sciences 0288

Lahore Campus

Theory of Automata (CS3005)

Sessional-I Exam

Date: November 1, 2025

Course Instructor(s)

Dr. Sobia Tariq, Dr. Tahir Ejaz, Dr. Aasim Qureshi, Mr. Hamad ul Qudous, Ms. Saba Tariq, Ms. Saba Sajjid, Ms. Rubab Anam

Total Time (Hrs.):	**1**
Total Marks:	**35**
Total Questions:	**2**

24L-0604 Roll No

BCS-3G Section

Student Signature

Do not write below this line

Attempt all questions. Show all workings on the answer sheet and record the final answers in the designated spaces on the question paper. Marks will not be awarded for answers without workings or if the final answer is not written in the specified space on the question paper. Attach the answer booklet to this question paper.

CLO 3	CLO 3	
Question 1 (23)	Question 2 (12)	Total Marks (35)
		35

CLO #: 3

Q1: *Develop PDA for the following language.* *[marks 5 + 18]*

$$L = \{a^i b^j c^k d^l \; ; \; i == k \;\; or \;\; 3j == l \; or \; j == 2k \; ; \; i,j,k,l \geq 0\}$$

Enumerate at least 10 strings from the language in canonical order, ensuring that at least three strings are included for each case [i==k or 3j==l or j==2k]).

1.	Λ	6.	aa
2.	a	7.	ac
3.	b	8.	ad
4.	c	9.	~~bd~~ bb
5.	d	10.	~~aaa~~ bd

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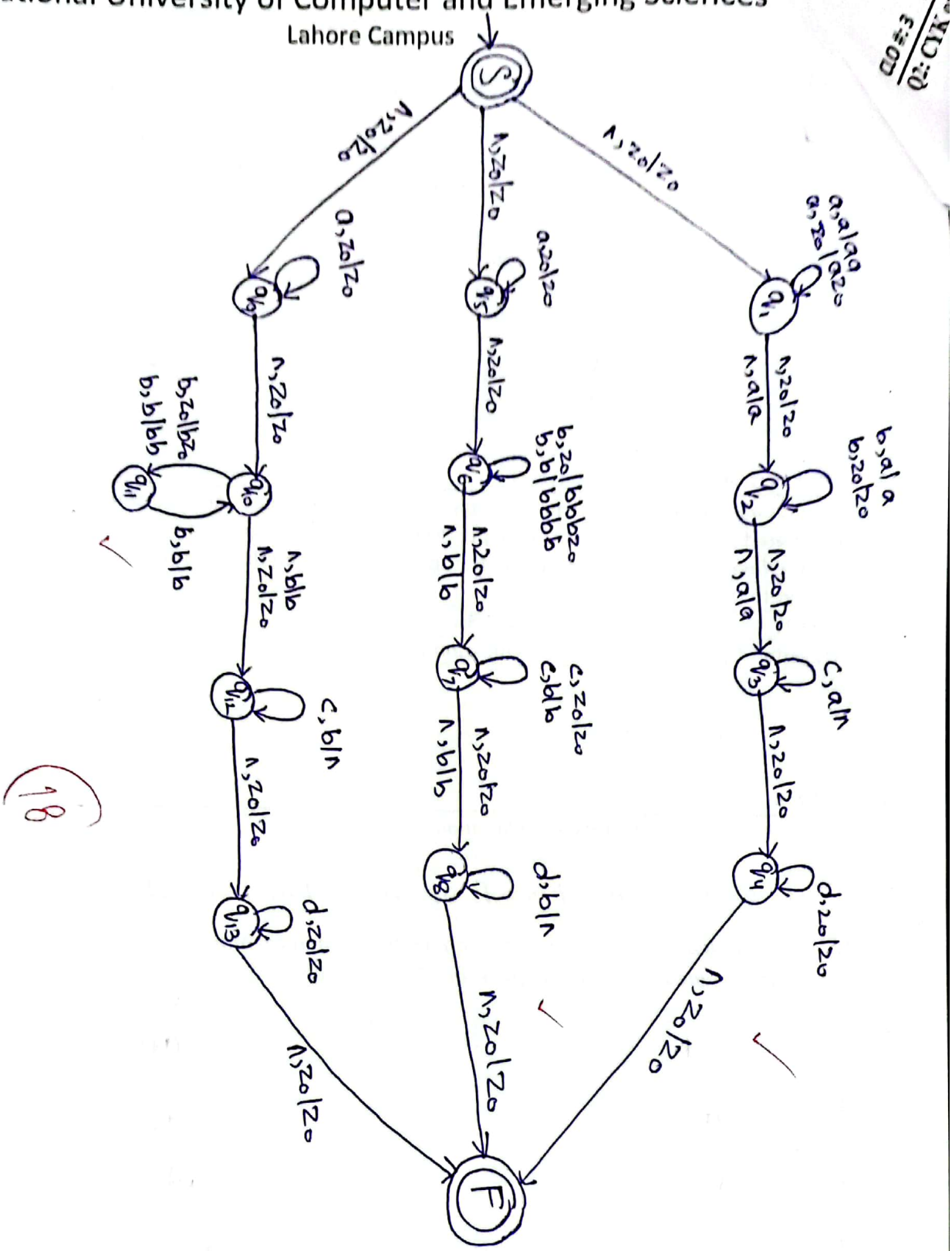
S
F
q1
q2
q3
q4
q5
q6
q7
q8
q9
q10
q11
q12
q13
a, a/aa
a, b/ab
a, ∧/∧
b, a/a
b, b/bb
b, ∧/∧
c, a/a
c, b/b
c, ∧/∧
d, a/a
d, b/b
d, ∧/∧
∧, ∧/∧

CLO #: 3

Q2: CYK on Robot Instructions **[10+2 marks]**

Σ = {Left, Right, forward, turn, step, rotate}
Consider each element in Σ as a single terminal. Left is 1st terminal, Right is 2nd terminal, and so on. So there are a total of 6 terminals.
V = {S, M, D, T, S_1, S_2)
A small robot understands this grammar in **CNF form**:

S → **MD** | **MT**
M → *Left* | *Right*
D → **S_1D** | *forward*
T → **S_2T** | *turn*
S_1 → *step*
S_2 → *rotate*

(Note: Grammar is already in CNF).
Apply the **CYK algorithm** to check if the instruction x = ***"Left step step step forward"*** belongs to the Language generated by the above-mentioned grammar.
Note: ***"Left step step step forward"*** *is a string with 5 terminals, as each element in Σ is a single terminal. Use only the required cells in the table given below (ignore the rest).*

X_{15} {S}				
X_{14} ϕ	X_{25} {D}			
X_{13} ϕ	X_{24} ϕ	X_{35} {D}		
X_{12} ϕ	X_{23} ϕ	X_{34} ϕ	X_{45} {D}	
X_{11} {M}	X_{22} {S_1}	X_{33} {S_1}	X_{44} {S_1}	X_{55} {D}
Left	step	step	step	forward

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Accept/Reject