GURU NANAK INSTITUTE OF TECHNOLOGY
An Autonomous Institute under MAKAUT
2021
FORMAL LANGUAGE AND AUTOMATA THEORY
CS403

TIME ALLOTTED: 3 HOURS **FULL MARKS: 70**

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable

GROUP – A
(Multiple Choice Type Questions)

Answer any ***ten*** from the following, choosing the correct alternative of each question: **10×1=10**

		Marks	CO No
1. (i)	If R=P+RQ then which of the following is true? a) R=PQ* b) R=QP* c) R=P*Q d) R=Q*P	1	CO1
(ii)	The Regular Expression representing the set of all strings over Σ={0,1} starting with 0 and ending with 01 is a) 0*(0+1)*01 b) 0(0+1)*01 c) 001(0+1)* d) (0+1)*001	1	CO2
(iii)	Which of the following Regular Expressions over {a,b} denotes the set of all strings **NOT** containing **baa** as substring a) a*(b*a)* b) a*baba* c) a*b*a*b* d) a*(ba+b)*	1	CO3
(iv)	The set of all strings over the alphabet S = {a, b} (including ε) is denoted by a) (a + b)* b) $(a + b)^+$ c) a+b+ d) a*b*	1	CO3
(v)	If L1 and L2 are context free language and R a regular set, then which one of the languages below is not necessarily a context free language? a) L1 L2 b) L1 ∩ L2 c) L1 ∩ R d) L1 ∪ L2	1	CO3
(vi)	Which of the following statement is TRUE? a) Merger graph is a directed graph b) Compatibility graph is a directed graph c) Both merger graph and compatibility graph are directed graphs d) Neither merger graph nor compatibility graph is directed	1	CO2

(vii)	Input sequence of an information lossless machine can be determined from the knowledge of a) Only output sequence b) Output sequence and initial state c) Output sequence and initial state and final state d) Initial state and final state		1	CO3
(viii)	Which is NOT a part of the mechanical diagram of 'Turing Machine'? a) Input tape b) read-write head c) Finite Control d) Stack		1	CO3
(ix)	Maximum no of states of a DFA converted from a NFA with n states is a) n b) n^2 c) 2^n d) None of these		1	CO3
(x)	Language of finite automata is a) Type 0 b) Type 1 c) Type 2 d) Type 3		1	CO4
(xi)	In Moore machine output is associated with a) present state only b) Next state only c) Present state and input only d) input only		1	CO3
(xii)	The following transitions represent δ (q0, a, Z0) = (q0, aZ0) δ (q0, a, a) = (q0, aa) δ (q0, b, a) = (q1, ε) δ (q1, b, a) = (q1, ϵ) δ (q1, ϵ, Z0) = (q1, ε) a) acceptance of L = {$a^n b^n$, n≥1} without empty stack b) acceptance of L = {$a^n b^n$, n≥0} with empty stack c) acceptance of L = {$a^n b^n$, n≥1} with empty stack d) acceptance of L = {$a^n b^n$, n≥0} without empty stack		1	CO4

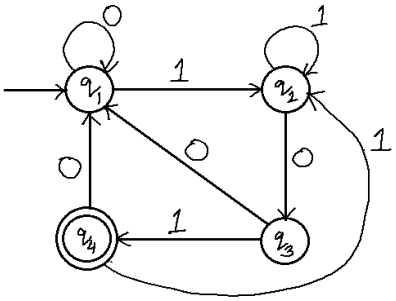
GROUP – B
(Short Answer Type Questions)

Answer any ***three*** from the following: **3×5=15**

			Marks	CO No
2.	(a)	Construct a CFG for palindrome for binary numbers.	2	CO4
	(b)	Construct a CFG for **L = { a^n b^n c^m d^m | m, n > 0 }**	3	CO4
3.	(a)	Define NFA.	2	CO3
	(b)	Design a Finite Automata (FA) that accepts set of all strings over Σ = {a,b} such that every string ends with aba.	3	CO3
4.	(a)	Design a DFA for RE **$(0+l)^*(01)(011)^*$**	3	CO3

(b) Consider a CFG with the following productions: 2 CO3
P: $S \rightarrow aSb \mid SS \mid \epsilon$
For the string **aabb**, how many derivation trees are possible? Explain.

5. Find out the regular expression corresponding to the following DFA: 5 CO3



6. Design a Turing machine for accepting a language $L(G)=\{a^n b^n\}$ n>=1. 5 CO5

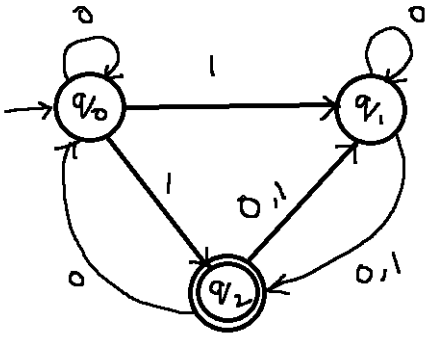
GROUP – C
(Long Answer Type Questions)
Answer any ***three*** from the following: **3×15=45**

			Marks	**CO No.**
7.	(a)	What do you mean by equivalent states and k-equivalent states?	2	CO1
	(b)	Consider the following Machine:	13	CO1

PS	NS, z			
	I_1	I_2	I_3	I_4
→A	-	-	E,1	-
B	C,0	A,1	B,0	-
C	C,0	D,1	-	A,0
D	-	E,1	B, -	-
E	B,0	-	C, -	B,0

Draw the Merger Graph.
Draw the Compatibility Graph.
Find the minimal machine equivalent to the above machine.

8. (a) Draw the DFA equivalent to the following NFA. 6 CO3



(b) State the differences between Mealy and Moore machine. 3 CO1

(c) Minimize the following Mealy Machine. 6 CO1

	NS, z	
PS	$x = 0$	$x = 1$
A	B, 1	H, 1
B	F, 1	D, 1
C	D, 0	E, 1
D	C, 0	F, 1
E	D, 1	C, 1
F	C, 1	C, 1
G	C, 1	D, 1
H	C, 0	A, 1

9. (a) What is information lossless machine? 2 CO2

(b) Consider the following Machine: 6 CO2

PS	NS, z	
	x=0	x=1
→ A	A,0	B,0
B	C,0	D,0
C	D,1	C,1
D	B,1	A,1

For the above machine determine whether it is lossless or lossy. If it is lossless of finite order, determine its order.

(c) Prove that L = {w | w is a palindrome over {0, 1} is not regular. 5 CO3

(d) Write regular expression for the language such that every string will have at least one 'a' followed by at least one 'b' 2 CO3

10. (a) Define CFG and write down its properties. 4 CO3

(b) What is parse tree? 1 CO3

(c) Consider the grammar G = (V_n, V_t, P, S), where 2 CO3
V_n ={S} V_t = {a, b, c}
P: S → aSa
S → bSb
S → c
Find out the language for this CFG.

(d) Consider the following grammar with production rule 3 CO4
P: S → aA, S → b/∈
Remove the ∈-production from the above grammar.

(e) Design a PDA for the language L = {ww^R | w Є {a,b}$^+$}. Show the instantaneous descriptions (IDs) for the string **abba** for this language L(w) = {ww^R | w Є {a,b}$^+$}. 5 CO4

11. Write short notes on any ***three*** from the following: 3 × 5 = 15

(a) Chomsky classification of grammar 5 CO4

(b) Halting problem of Turing Machine 5 CO5

(c) Push-down Automata 5 CO5

(d) Left-most and Right-most Derivation 5 CO3

(e) Ambiguity in grammar 5 CO3