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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

January / February 2025 Semester End Main Examinations

Programme : B.E. | **Semester: III**
Branch: Artificial Intelligence & Machine Learning | **Duration: 3 hrs.**
Course Code: 22AM3PCTFC | **Max Marks: 100**
Course: Theoretical Foundations of Computations

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT - I	CO	PO	Marks
1	a)	Define a Deterministic Finite Automaton (DFA). Design a DFA to accept strings over the alphabet {0,1} that contain an even number of 0s.	CO1	PO1	06
	b)	Differentiate between Deterministic Finite Automata(DFA) and Non- deterministic Finite Automata(NFA) with examples. Prove that every NFA has an equivalent DFA using a suitable example.	CO1	PO2	06
	c)	i. Explain the process of minimizing a DFA. ii. Minimize the following DFA and show the steps involved Q={q0,q1,q2,q3}, Σ={0,1}, q0 is the start state, and F={q2} Transition Table:	CO1	PO2	08

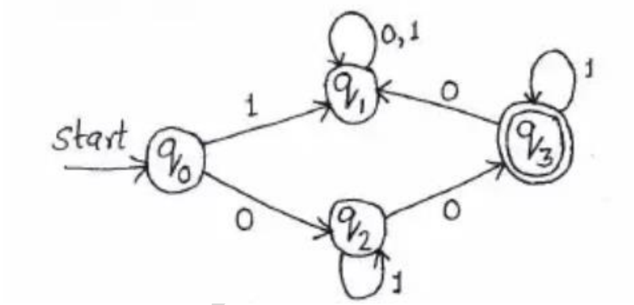
State	Input 0	Input 1
q_0	q_1	q_0
q_1	q_2	q_3
q_2	q_2	q_2
q_3	q_3	q_3

		OR			
2	a)	Discuss the significance of ϵ-transitions in automata. Provide an example where ϵ-transitions simplify the construction of an automaton.	CO1	PO1	05
	b)	i. Construct a Deterministic Finite Automata(DFA) to accept decimal strings divisible by 3. ii. Draw transition diagram and provide equivalent transition table for the constructed DFA.	CO1	PO3	08
	c)	Convert the following Non- deterministic Finite Automata(NFA) to its equivalent Deterministic Finite Automata(DFA).	CO1	PO2	07

δ	0	1
→p	{p, r}	{q}
q	{r,s}	{p}
*r	{p,s}	{r}
*s	{q, r}	null

UNIT - II

3	a)	Define Regular expression. Write the regular expression for the following languages: i. Representing for strings of a's and b's having odd length. ii. To accept strings of a's and b's such that third symbol from the right is a and fourth symbol from the right is b.	***CO1***	*PO2*	**06**
	b)	i. State and prove pumping lemma Theorem. ii. Show that , L= $\{WW^R \mid W \in \{a,b\}^*\}$ is not regular.	***CO1***	*PO2*	**06**
	c)	i. Prove that if L=L(A) for some Deterministic Finite Automata(DFA) A, then there is a regular expression R such that L =L(R). ii. Derive Regular expression for the Deterministic Finite Automata (DFA) using State Elimination Method.	***CO2***	*PO2*	**08**



OR

4	a)	Show that regular languages are closed under i. Union, concatenation and Kleens star ii. Intersection and Difference	***CO1***	*PO2*	**10**
	b)	Minimize the following DFA using the lazy evaluation method and show all the steps involved: DFA Description: States: $Q = \{q0, q1, q2, q3, q4\}$ Input Alphabet: $\Sigma = \{a, b\}$ Start State: q0 Final States: $F = \{q3, q4\}$	***CO1***	*PO2*	**10**

State	a	b
q_0	q_1	q_2
q_1	q_3	q_4
q_2	q_4	q_3
q_3	q_3	q_3
q_4	q_4	q_4

			UNIT - III			
	5	a)	Obtain the unambiguous grammar for the grammar shown and get the derivation for the expression (a+b)*(a-b). E→ E+E | E-E E→ E*E | E/E E→ (E) | I I→a|b|c	*CO2*	*PO2*	**06**
		b)	Consider the following grammar S→ AbB A→aA | Є B→ aB | bB | Є Give LMD and RMD and Parse tree for the string "aaabab"	*CO2*	*PO2*	**07**
		c)	Define GNF. Convert the grammar to GNF. Explain with detailed steps. S→ AB1 | 0 A→00A | B B→ 1A1	*CO2*	*PO2*	**07**
			OR			
	6	a)	Illustrate CFG. Design CFG for the languages i. L={0^{2n} 1^m | n>=0,m>=0 } ii. L={0^i 1^j 2^k |i=j or j=k}	*CO2*	*PO2*	**06**
		b)	Remove Є productions and unit productions from the grammar. S→ aA | aBB A→ aAA | Є B→ bB | bbC C→ B	*CO2*	*PO2*	**06**
		c)	Convert the following grammar to Chomsky Normal Form(CNF). S→ 0A | 1B A→ 0AA | 1S |1 B→ 1BB |0S |0	*CO2*	*PO2*	**08**
			UNIT - IV			
	7	a)	Define a Pushdown Automaton (PDA). Explain how it differs from a Finite Automaton (FA). Discuss real-world applications of PDA with examples.	*CO2*	*PO1*	**05**
		b)	Convert the following Context Free Grammar(CFG) to a Pushdown Automata (PDA) and show the moves on aabab. S → aSbb | aab S →AA | a A → SA | b.	*CO2*	*PO2*	**05**
		c)	i. Design a PDA to recognize the language L={w∈{a,b}∗ | w=w^R}, where w^R represents the reverse of w. ii. Justify whether it is deterministic or nondeterministic. iii. Explain the working of PDA taking a example string.	*CO2*	*PO3*	**10**
			OR			

	8	a)	i. Construct a PDA for the language L={w∈{(,)}∗ | w has balanced parentheses} ii. Show how the PDA processes the string w=(())().	***CO2***	*PO3*	**10**
		b)	Construct the equivalent CFG for the given PDA M=({q0, q1},{0,1},{X, Z0},δ,q0,Z) based on the specified transition functions: δ(q0,0,Z)= (q0, XZ) δ(q0,0,X)= (q0, XX) δ(q0,1,X)= (q1, ε) δ(q1,1,X)= (q1, ε) δ(q1, ε , X)= (q1, ε) δ(q1, ε, Z)= (q1, ε)	***CO2***	*PO2*	**10**
			UNIT - V			
	9	a)	Define a Turing Machine (TM) formally. Explain its components and the role of the tape in computation with an example.	***CO3***	*PO2*	**05**
		b)	Construct a Turing Machine that computes the sum of two unary numbers separated by a # symbol. For example, 111#11→11111 Describe its operation.	***CO3***	*PO3*	**10**
		c)	State and explain the Halting Problem. Prove that the Halting Problem is undecidable.	***CO1***	*PO1*	**05**
			OR			
	10	a)	i. Design a Turing machine to accept L={$0^n 1^n 2^n$ | n>=0}. ii. Draw the transition diagram. iii. Show the moves made for string aabbcc.	***CO3***	*PO3*	**10**
		b)	i. Explain post correspondence problem with its components. ii. For the alphabet {a,b}, consider the tiles: A=(a,ab), B=(ba,b), C=(b,aba). Verify whether there exists a finite solution for this instance. iii. Provide an example of tiles in the Post Correspondence Problem where no solution exists.	***CO3***	*PO1*	**10**

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