U.S.N.										

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

Autonomous Institute Affiliated to VTU

February 2025 Semester End Main Examinations

Programme: B.E. **Semester: IV**
Branch: Computer Science and Engineering **Duration: 3 hrs.**
Course Code: 23CS4PCTFC **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.

<table>
<tr><th></th><th></th><th>UNIT - I</th><th>CO</th><th>PO</th><th>Marks</th></tr>
<tr><td>1</td><td>a)</td><td>Design Deterministic Finite Automata (DFA) accepting the following strings over the alphabet set Σ ={a,b}
i. Set of all strings with at least one ‘a’ and exactly two b’s
ii. Set of all strings not containing the substring ‘abb’
iii. The set of all strings either begins or ends or both with substring ‘ab’</td><td>CO3</td><td>PO3</td><td>10</td></tr>
<tr><td></td><td>b)</td><td>Convert the following NFA to a DFA
<table><tr><th></th><th>0</th><th>1</th></tr><tr><td>→p</td><td>{q , s}</td><td>{q}</td></tr><tr><td>*q</td><td>{r}</td><td>{q, r}</td></tr><tr><td>r</td><td>{s}</td><td>{p}</td></tr><tr><td>*s</td><td>∅</td><td>{p}</td></tr></table></td><td>CO2</td><td>PO2</td><td>6</td></tr>
<tr><td></td><td>c)</td><td>Design DFA for accepting binary strings which begin with 101 over the alphabet set Σ ={0, 1}</td><td>CO3</td><td>PO3</td><td>4</td></tr>
<tr><td></td><td></td><td>OR</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td>a)</td><td>Design Non-deterministic Finite Automata (NFA) for the following
i. To accept the language which has ‘aab’ as substring over the alphabet set Σ ={a,b}
ii. To accept the language L(aa*(a+b))
iii. To accept the language L={a^3 U a^{2n}, n>=1}
iv. To accept the set of all strings whose second last symbol is 1 over the alphabet set Σ = { 0,1}
v. To accept all strings of 0’s and 1’s such that either second or third position from the end has 1 over the alphabet set Σ = { 0,1}</td><td>CO3</td><td>PO3</td><td>10</td></tr>
<tr><td></td><td>b)</td><td>Given the following ε-NFA obtain its equivalent DFA using ε-closure.</td><td>CO2</td><td>PO2</td><td>6</td></tr>
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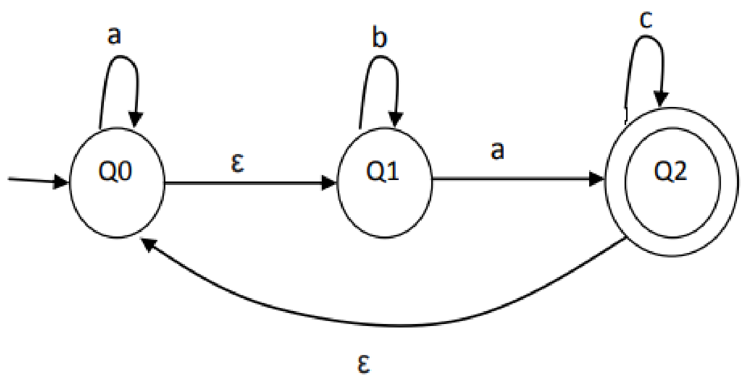
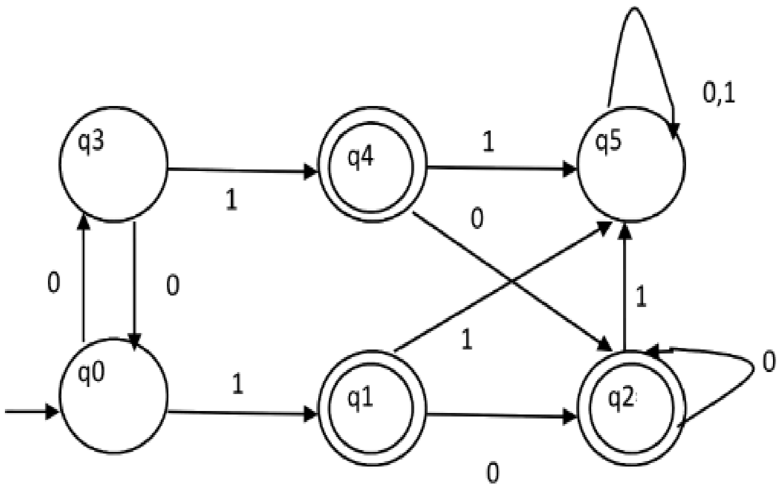
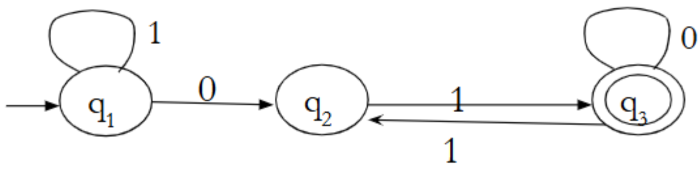


	c)	Design DFA for the following language over the alphabet set $\sum = \{a, b\}$ $L=\{w \mid n_a(w) \bmod 3 == 0\}$	*CO3*	*PO3*	**4**
		UNIT - II			
3	a)	Obtain Regular Expressions (RE) for the following language over the alphabet set $\Sigma = \{a, b\}$ i. Strings of a's and b's containing no more than three a's ii. Strings of a's and b's such that fourth symbol from right end is 'a' and fifth symbol from right end is 'b' iii. Set of string of a's and b's having substring 'aa' iv. Strings of a's and b's ending with either 'ab' or 'ba' v. $L = \{a^n b^m, n>=1, m>=1, nm>=3\}$	*CO2*	*PO2*	**10**
	b)	Design minimized DFA using the concept of table filling algorithm for the DFA given below. Note: Show the minimization steps completely and clearly.	*CO3*	*PO3*	**10**



		OR			
4)	a)	State the Pumping Lemma. Show that the languages given below are not regular. i. $L=\{a^n b^n, n>=0\}$ ii. $L=\{ww^R, w \in (0+1)^*\}$	*CO2*	*PO2*	**10**
	b)	Convert following Finite Automata to Regular Expression using Kleene's theorem by elaborating each step.	*CO3*	*PO3*	**10**

						
			UNIT - III			
	5	a)	Design Context Free Grammar (CFG) to accept i. L = { a^nb^m , $n \geq 0$, $m > n$} ii. L = { $a^nb^mc^k$, (n+2m) == k , $n \geq 0$, $m \geq 0$ } iii. L = {w, $n_a(w) == n_b(w)+1$, w ∈ (a+b)*} iv. L = {x, x ∈ (a+b)* and |x| is even } v. L = {a^nb^n , n > 0}	*CO3*	*PO3*	**10**
		b)	Eliminate useless symbols in the grammar given below: S → aA | bB A → aA | a B → bB D → ab | Ea E → aC | d **Note:** Show the solving steps completely and clearly.	*CO2*	*PO2*	**10**
			OR			
	6	a)	Convert following Grammar to Chomsky Normal Form (CNF) S → aXbX , X → aY | bY | **ε** , Y → X | c **Note:** Show the solving steps completely and clearly.	*CO2*	*PO2*	**10**
		b)	i) Eliminate ε-Productions (Epsilon Productions) from the following grammar S → XY X → a Y → CD C → aC | ε D → bDa | ε ii) Eliminate all unit productions from the following Grammar S → AB A → a B→C | b C→D D→E | bC E→d |Ab	*CO2*	*PO2*	**10**
			UNIT - IV			
	7	a)	Design Deterministic Push Down Automata (PDA) for the language L={W, W ∈ (a+b)* and $n_a(w) > n_b(w)$} by final state method. Write the formal definition of the obtained PDA.	*CO3*	*PO3*	**10**
		b)	Show that the context-free languages (CFL) are closed under Concatenation and union operation with an example.	*CO1*	*PO1*	**10**

			OR			
	8	a)	Construct PDA to recognize the language L={$a^{2n}b^n$, n>=1} by empty stack method. Show the moves made by PDA for the string aaaabb and aabbb.	***CO2***	***PO2***	**10**
		b)	Show that the languages i. L={W , W ∈ (0+1)* , |w| is a perfect square } ii. L={$a^nb^nc^n$, n≥0} are not Context Free Languages (CFL).	***CO1***	***PO1***	**10**
			UNIT - V			
	9	a)	Give the formal definition of Turing Machine and design a TM for Design Turing Machine for L= {0^n1^n, n>=1}.	***CO3***	***PO3***	**10**
		b)	Describe the Post correspondence problem. Determine whether the following (A, B) pair have a Post Correspondence solution or not. If yes, give the solution, if no, why. Justify. A = {b, bab^3, ba} B = {b^3, ba, a}	***CO2***	***PO2***	**10**
			OR			
	10	a)	Design a Turing Machine for the language L={WW^R, W ∈ (a+ b)*}.	***C03***	***PO3***	**10**
		b)	Find a Post Correspondence Solution for following two lists given. i. A = (b , babbb , ba) and B = (bbb , ba , a) ii. A = (100, 0, 1) and B = (1, 100, 00)	***CO2***	***PO2***	**10**

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