U.S.N.										

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

Autonomous Institute Affiliated to VTU

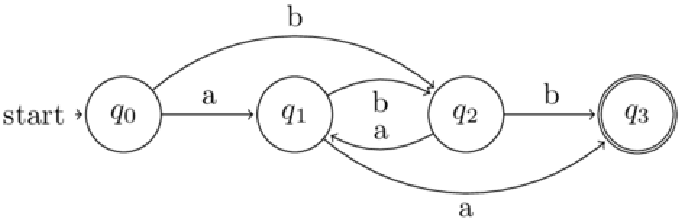
April 2024 Semester End Main Examinations

Programme: B.E.	**Semester: III**
Branch: Artificial Intelligence and Machine Learning	**Duration: 3 hrs.**
Course Code: 23AM3AETFC	**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.

<table>
<tr><th></th><th></th><th>UNIT - I</th><th><i>CO</i></th><th><i>PO</i></th><th>Marks</th></tr>
<tr><td>1</td><td>a)</td><td>Define and design Deterministic Finite Automata (DFA) for the languages:
i. $L=\{w(ba+ab) \mid w\ Ɛ\ (a,b)^*\}$
ii. $L=\{w \mid N_a(w) \bmod 2=0 \text{ and } N_b(w) \bmod 2=0\}$
iii. To accept string of 0’s and 1’s having the substring 001.
iv. To accept string of a’s and b’s having no more than three a’s.</td><td><i>CO 2</i></td><td><i>PO 2</i></td><td>10</td></tr>
<tr><td></td><td>b)</td><td>Convert the given Non-Deterministic Finite Automata (NFA) to its equivalent DFA and conclude your answer in the 5 -tuple format.
<table>
<tr><td></td><td>0</td><td>1</td></tr>
<tr><td>→q0</td><td>q0, q1</td><td>q1</td></tr>
<tr><td>*q1</td><td>q2</td><td>q2</td></tr>
<tr><td>q2</td><td>Φ</td><td>q2</td></tr>
</table></td><td><i>CO 2</i></td><td><i>PO 2</i></td><td>10</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>Apply the relevant algorithm and minimize the DFA.
<table>
<tr><td></td><td>a</td><td>b</td></tr>
<tr><td>→q0</td><td>q1</td><td>q3</td></tr>
<tr><td>q1</td><td>q2</td><td>q4</td></tr>
<tr><td>q2</td><td>q1</td><td>q4</td></tr>
<tr><td>q3</td><td>q2</td><td>q4</td></tr>
<tr><td>*q4</td><td>q4</td><td>q4</td></tr>
</table></td><td><i>CO 3</i></td><td><i>PO 2</i></td><td>08</td></tr>
<tr><td></td><td>b)</td><td>Given ε- NFA
<table>
<tr><td></td><td>ε</td><td>a</td><td>B</td><td>c</td></tr>
<tr><td>→q0</td><td>q1</td><td>q0</td><td>Φ</td><td>ϕ</td></tr>
<tr><td>q1</td><td>q2</td><td>ϕ</td><td>q1</td><td>ϕ</td></tr>
<tr><td>*q2</td><td>ϕ</td><td>ϕ</td><td>Φ</td><td>q2</td></tr>
</table>
a. Compute the ε closure of each state.
b. Convert the automata to a DFA.</td><td><i>CO 3</i></td><td><i>PO 3</i></td><td>08</td></tr>
</table>

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.

		c)	Construct NFA to accept i. Strings containing 1100 or 1010 as a substring. ii. L={w|w ε abab^n or aba^n where n>=0}	***CO1***	***PO1***	**04**
			UNIT - II			
	3	a)	Convert the DFA to regular expression using state elimination method. 	***CO1***	***PO1***	**8**
		b)	Write regular expression to accept i) String of a's and b's of length <=10. ii) String of a's and b's whose length is either even or multiple of 3 or both. iii) L= {a^{2n}b^{2m} | n>=0,m>=0}	***CO 2***	***PO 1***	**6**
		c)	State pumping lemma theorem for regular languages and prove that $L = \{ x \mid x$ contains an equal number of 0s and 1s } is not regular.	***CO 2***	***PO 1***	**6**
			UNIT - III			
	4	a)	Show that the grammar is ambiguous for the string= "001101" S→0B | 1A A→0S | 1AA | 0 B→1S | 0BB | 1	***CO 2***	***PO 2***	**6**
		b)	Simplify S→ ABCa | bD A→ BC | b B→ b | ε C→ c | ε D→ d	***CO 2***	***PO 3***	**6**
		c)	Convert the given Context Free Grammar (CFG) to Chomsky Normal Form (CNF). S -> aAa | bBb | ε A -> C | a B -> C | b C-> CDE | ε D -> A | B | ab	***CO 3***	***PO1***	**8**
			OR			
	5	a)	Write Context Free Grammar (CFG) for the languages: i. L= {w | n$_a$(w)=n$_b$(w)} ii. L= {ww^r where w ε (a,b)*} iii. String consisting of any number of a's and b's with atleast one a. iv. L= {a^{n}b^m | n>=0, m>n}	***CO3***	***PO1***	**8**
		b)	Provide the formal description of CFG. Outline the steps to prove a language is not context free.	***CO2***	***PO1***	**7**

		c)	Identify the language represented by i) $S \rightarrow 0S1 \mid A \mid B$ $A \rightarrow 0A \mid 0$ $B \rightarrow 1B \mid 1$ ii) $S \rightarrow aSa \mid bSb \mid A$ $A \rightarrow aBb \mid bBa$ $B \rightarrow aB \mid bB \mid \varepsilon$	***CO3***	***PO2***	**5**
			UNIT - IV			
	6	a)	Construct a PDA for the language $L = \{wCw^r \mid w \varepsilon (a+b)^*\}$.Verify whether the given string aabCbaa is accepted or not.	***CO3***	***PO2***	**10**
		b)	Convert the given CFG to PDA. $S \rightarrow aABB \mid aAA$ $A \rightarrow aBB \mid a$ $B \rightarrow bBB \mid A$ $C \rightarrow a$	***CO3***	***PO3***	**10**
			UNIT - V			
	7	a)	Design a Turing Machine (TM) to accept the language $L=\{0^n1^n, n>=1\}$. Are the strings 000111 and 001111 is accepted by the TM? Justify.	***CO3***	***PO1***	**10**
		b)	Elaborate on i. Universal Turing Machines ii. Undecidable problems	***CO3***	***PO1***	**5**
		c)	State Post Correspondence Problem (PCP). Determine whether the lists M = (abb, aa, aaa) and N = (bba, aaa, aa) has a Post Correspondence Solution or not.	***CO3***	***PO3***	**5**

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