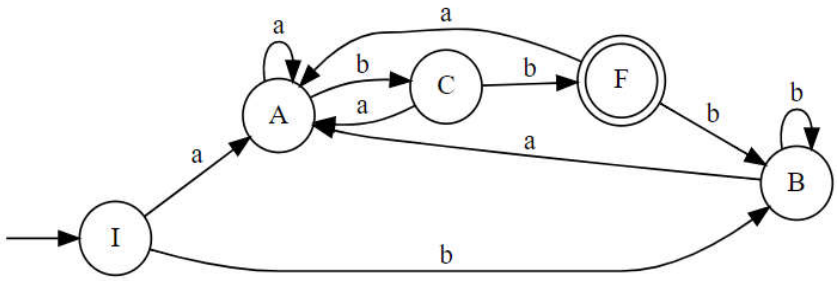
Master of Computer Applications
MCAC 303: Automata Theory
Unique Paper Code: 223401303

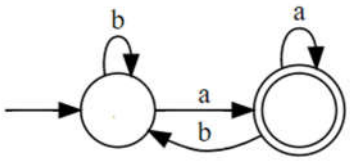
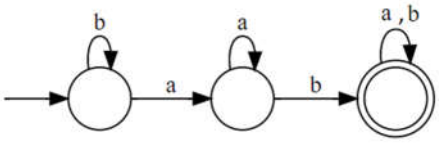
Semester III
December-2021
Year of admission: 2020

Time: Three Hours **Max. Marks: 70**

Instructions:

1. Answer any 4 questions. All questions carry equal marks.
2. Notations have their usual meaning.
3. Assume $\sum = \{a, b\}$ as the underlying alphabet unless mentioned otherwise.

1.	• Construct a minimum state finite automaton equivalent to the following finite automaton:  	7 marks
	• Construct regular expression and the corresponding finite automaton (FA) for the language: $L = \{w \in \Sigma^* \; and \; \lvert w \rvert > 0$: each '$\boldsymbol{b}$' is immediately preceded by '$\boldsymbol{a}$'$\}$.	7 marks
	• Is the union of a family of regular languages necessarily regular? Justify your answer.	3.5 marks
2.	• Using pumping lemma, show that the language L: $\{a^{n+m}b^m c^n$; m, n >= 1$\}$, is not regular over the alphabet $\sum = \{a, b, c\}$.	6 marks
	• For the above language L, do the following: o Write a context free grammar (CFG) and construct parse tree for the word aaabbc	5.5 marks
	o Build a pushdown automaton (PDA)	6 marks

3.	• Design a 2-tape Turing machine defined over the alphabet $\sum = \{0,1\}$ to perform the addition of two binary numbers. Trace the computation of the constructed Turing machine for the two binary strings **0110** and **0010**. • Do the machines **LR** and **RL** always accomplish the same thing? Justify your answer.	13 marks 4.5 marks
4.	• Is the language **L = {$a^n b^n a^n b^n a^n$ where n ≥ 1}** context free? Justify your answer. • Consider the following context free grammars (CFGs): $G1$: $S \rightarrow bS \mid aX$; $X \rightarrow bS \mid aY$; $Y \rightarrow aY \mid bY \mid a \mid b$ $G2$: $S \rightarrow XaX \mid bX$; $X \rightarrow XaX \mid XbX \mid \in$ $G3$: $S \rightarrow A \mid AA$; $A \rightarrow B \mid BB$; $B \rightarrow abB \mid b \mid bb$ $G4$: $S \rightarrow BABABA$; $A \rightarrow a$; $A \rightarrow b$ Perform the following: o Write a regular expression for the language represented by G1 o Convert G2 into its equivalent CFG without null (∈)-production o Convert G3 into its equivalent CFG without unit-production o Convert G4 to Chomsky Normal Form (CNF)	5.5 marks 12 marks
5.	• Show the step-wise construction of Non-deterministic Finite Automaton (NFA) for the regular expression $\boldsymbol{ba + (a + bb)a^*b}$. Also, convert the above NFA to corresponding Deterministic Finite Automaton (DFA). • For languages **L_1** and **L_2** described by the corresponding regular expressions $(\mathbf{a + b})^*\boldsymbol{a}$ and $(\mathbf{a + b})^*\mathbf{b}$, construct the following a) DFA for **L_1** and **L_2** and b) DFA that defines **$L_1 \cap L_2$**.	10.5 marks 7 marks
6.	• Consider the following two Deterministic Finite Automata **FA_1** and **FA_2**. FA1:  FA2:  Perform the following: • Give regular expressions corresponding to **FA_1** and **FA_2**. • Construct the DFA for **FA_1.FA_2**. • Design a deterministic pushdown automaton for the language L: $\{a^n c\ b^n : n \geq 1\}$	10 marks 7.5 marks