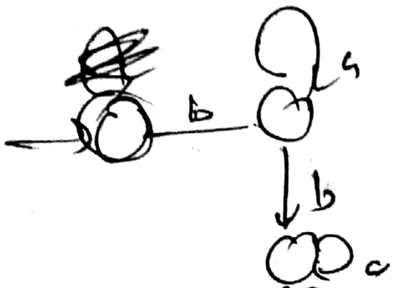

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Master of Computer Applications
MCAC 303: Automata Theory
Unique Paper Code: 223401303

Semester III
December-2022
Year of admission: 2021

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

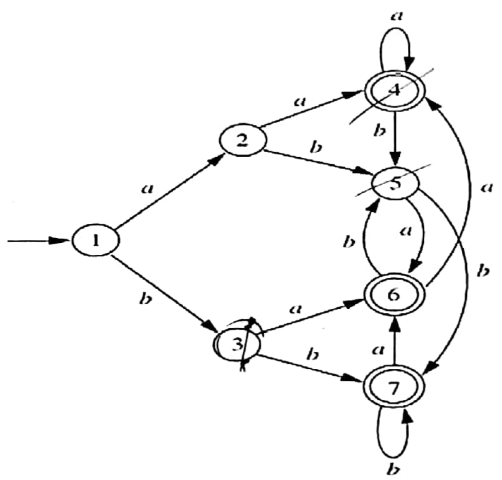
Instructions:

abbbb

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

1. Construct regular expression and the corresponding non-deterministic finite automaton (NFA) for the language $L = \{w \in \Sigma^*\text{: w has } 3k + 1\ \boldsymbol{b's} \text{ for } k \geq 0\}$.

2. Construct a minimum state finite automaton equivalent to the following finite automaton:



3. For languages L_1 and L_2, described by the following finite automata (FA), construct the FA that defines $L_1 + L_2$.

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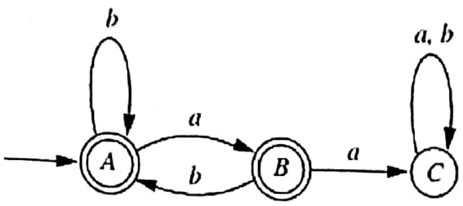
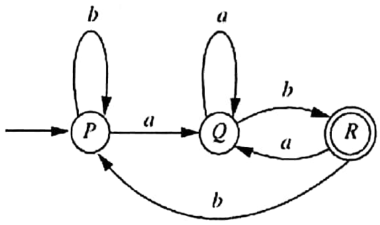


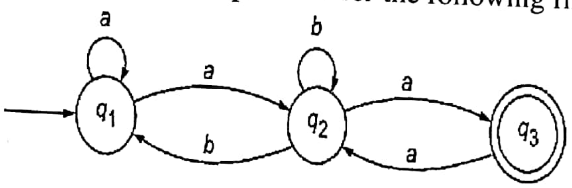
FA₁ (L₁)



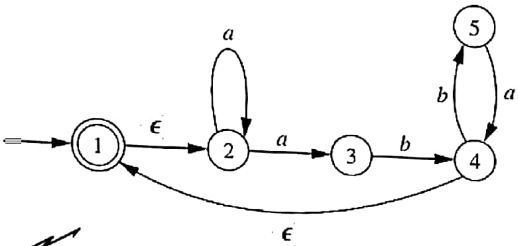
FA₂ (L₂)

4. For languages, L_1 and L_2, described by the regular expressions $(\mathbf{ab}^*)^*$ and $(\mathbf{b}+\mathbf{ab})^*(a+\epsilon)$, respectively, construct the following:
a) DFA for L_1 and L_2
b) DFA that defines $L_1 \cap L_2$.

5. Find the regular expression for the following finite automaton using Arden's Theorem:



6. Construct a deterministic finite automaton for the following $NFA-\epsilon$:



$n+m=k$

$a^i a^{n-i} b^m$

$a^{2n-i} b^n$

7. Use pumping lemma to check whether the language $L: \{a^n b^m : n+m \text{ is prime}\}$ is regular or not.

$2n-i+m$

8. Describe the language generated by the following context-free grammar (CFG):

$$S \rightarrow SS$$
$$S \rightarrow XXX$$
$$X \rightarrow aX \mid Xa \mid b$$

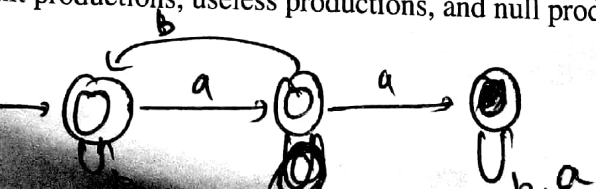
$a^{n-i} a^{i} b^{i^2} b^{n-i}$

Also, convert the CFG into Chomsky Normal Form (CNF).

9. Consider the following context-free grammar (CFG):

$$S \rightarrow aA \mid aBB$$
$$A \rightarrow aaA \mid \epsilon$$
$$B \rightarrow bB \mid bbC$$
$$C \rightarrow B$$

Eliminate all unit productions, useless productions, and null productions from CFG.



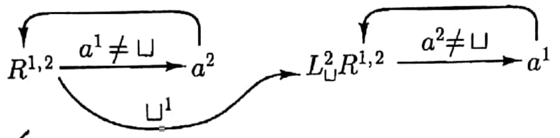
10. Use CYK algorithm to check whether the string $w = aabbb$ is in the language generated by the following grammar:

$$S \to AB$$
$$A \to BB \mid a$$
$$B \to AB \mid b$$

11. Is the language $\{wcw^R : w \in \Sigma^*\}$ deterministic? If yes, construct the pushdown automaton (PDA).

12. Construct the Turing Machine (TM) that semi-decides the language $L: \{a^n b^n c^n : n \geq 0\}$

13. Assuming the content of the first and second tapes is $\triangleright\underline{\sqcup}ab$ and $\triangleright\underline{\sqcup}$, respectively, describe the operation of the following 2-tape TM:



14. Prove that recursive languages are closed under complementation.

abbacbba

SB , BB

{A}. {S;B}

AS , AB

{S,B} {B}