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3rd Year 1st Semester B.Sc. (Engg.) Final Examination 2023

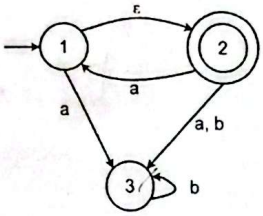
Course Title: Theory of Computation — Marks: 70
Course Code: ICT 3107 — Time: 3 hours

Answer any 05 (FIVE) questions

1. a) Give the formal definition of Finite automation. Briefly describe the purpose and motivation of the theory of computation. 3

b) Define Language, String, Alphabet and Symbol. 2

c) Convert the following non-deterministic finite automata to equivalent deterministic finite automata: 4



d) Define NFA. For each of the following languages, construct an NFA that accepts the language. In all cases, the alphabet is { a, b }. 5
i) { w : w contains the substring bbaab }
ii) { w : w has length at least 2 and does not end with ba }
iii) { w : w begins with b or ends with a }
iv) { w : w begins with a or ends with b }

2. a) *Draw an NFA with* $\Sigma = \{ 0, 1 \}$ such that the third symbol from the right is "1". 4

b) *Let* $\Sigma = \{ a, b \}$ *and let* $L = \{ w \in \Sigma^* \mid$ the third-from-last character of w is a $\}$. *Design an NFA for L.* (**N.B.** Your NFA should use at most four states) 5

c) Convert the following epsilon-NFA (**see Figure 1**) to NFA. Consider the example having states S0, S1, S2, S3, and S4. 5

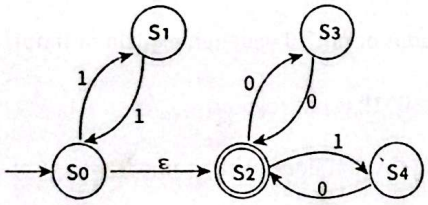


Figure 1: An Epsilon NFA for Question No [2 (c)]

3. a) Is it possible to convert any NFA to a DFA? Consider the following NFA (**see Figure 2**). Find out the respective DFA with 5 tuples if it is truly possible. 6

b) What is DFA minimization? What are the benefits of state minimization? 2

c) Using Myhill–Nerode theorem or Equivalence theorem, minimize the following DFA (**see Figure 3**), and redraw the minimized DFA and specify all tuples. 6

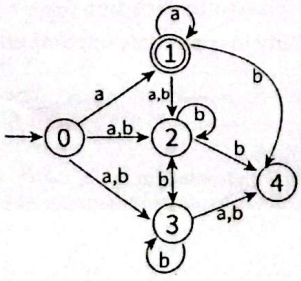


Figure 2: A FA for Question No [3 (a)]

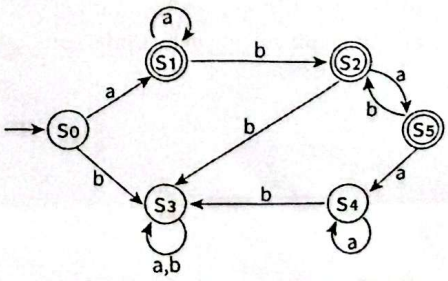


Figure 3: A DFA for Question No. [3 (c)]

4. a) What are the differences between the Mealy machine and the Moore machine?

b) Construct a Moore machine that counts the occurrences of the sequences 'bab' in any input string over { a, b }. Now compute how many time(s) the sequences of "bab" is (are) found inside a given sequence "bbaababababbbaba". 5

c) Convert the given Moore Machine to its equivalent Mealy Machine:

State	0	1	Output
q_0	q_1	q_2	1
q_1	q_3	q_2	0
q_2	q_2	q_1	1
q_3	q_0	q_3	1

5. a) Define Regular Expression. For the following regular expression, find an equivalent NFA. 5

i) (ab U a)*

ii) (a U b) * aba

b) Determine the regular expression for L = [Set of all strings ∑ = { a, b } where the 3rd symbol from the right-hand side is always a]. 4

c) What do you mean by context-free language (CFL) and context-free grammar (CFG)? Convert CFL to CFG for $a^n b^n, n \geq 0$. 4

6. a) *Given a CFG defined by G = (N, T, P, S) with N = { S }, T = { a, b }* 4.5

$$P = \begin{cases} (i)\ S \rightarrow aSb \\ (ii)\ S \rightarrow aSb \end{cases}$$

Obtain the derivation tree and the language generated L(G).

b) Check whether the given grammar is ambiguous or not? 4.5

S → AB / C
A → aAb/ab
B → cBd / cd
C → aCd / aDd
D → bDc / bc

i) Is it possible to obtain the string "aabbccdd" using (α) leftmost derivation, and (β) rightmost derivation?

ii) Is the above-mentioned grammar ambiguous or not? If yes then explain or if not, then explain why?

c) Prove by pumping lemma, that the language $0^n 1^n$ is not regular. 5

7. a) Give a formal definition of PDA. Construct a PDA that decides the same language as does the following CFG: 7

P ⇒ 0 Q 1 V 1
Q ⇒ Q 0 V ϵ

b) Convert the following CFG into an equivalent CFG in Chomsky Normal Form: 7

A ⇒ BAB V B V ϵ
B ⇒ 00 V ϵ

8. a) State the formal definition of Turing Machine. List down various features of the Turing Machine. 5

b) Design a Turing Machine for $\{ a^n b^n c^n | n \geq 1 \}$. Demonstrate each step for n = 2. 7

c) What do you mean by Undecidability and Reducibility in the theory of computing? 2