ROLL NO:

NAME:

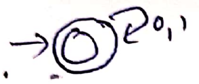
INDIAN INSTITUTE OF INFORMATION TECHNOLOGY,
DESIGN AND MANUFACTURING, KANCHEEPURAM

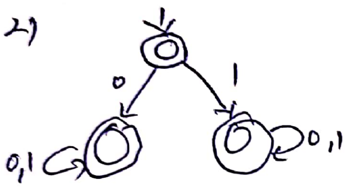
MID-SEM CS 2009 Theory of Computation 26-Feb-2025 25 Marks

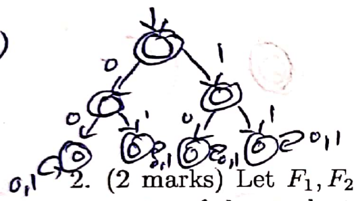
0. Name the organization that provides 1.5 Lakh free meals every day to school children.....

1. (2 marks) How many different DFAs are possible for the language $L = \Sigma^*$. Present a precise justification.

Let $\Sigma = \{0,1\}$.

1) 

2) 

3) 

1) For every fixed integer k, we can construct a DFA in which there are k-levels.

2) Σ^* is divided into 2^k Equivalence classes
E_1 : strings beginning with 0...0
E_2 '' 0...1
E_{2^k} '' 1...1

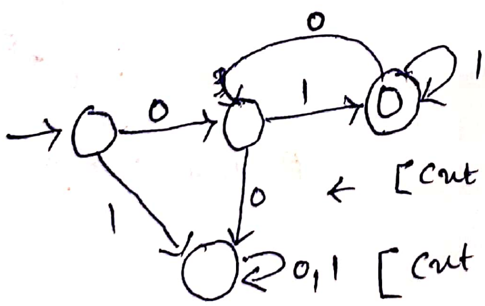
3) # DFAs = # possible values for k = Countably ∞.

2. (2 marks) Let F_1, F_2 denote the final states of DFAs M_1 and M_2, respectively. What are the final states of the product automaton in each of the following cases

0.5 each

- $M_1 \cap M_2$ - $F_1 \times F_2$
- $M_1 \cup M_2$ - $(F_1 \times Q_2) \cup (Q_1 \times F_2)$
- $M_1 - M_2$ - $(F_1 \times (Q_2 - F_2))$
- M_1^c - $Q_1 - F_1$

3. (2 marks) Let $\Sigma = \{0,1\}$. $L = \{x \mid x \in \Sigma^*$ such that x begins with 0, ends with 1, and does not contain 00 as a substring$\}$. Design a DFA if exists.



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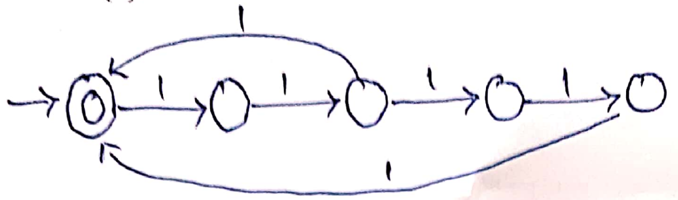
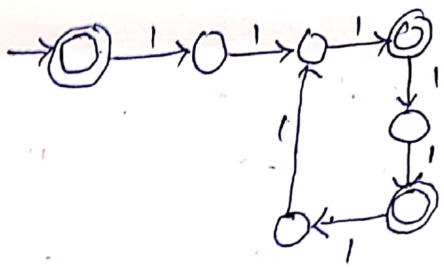
For missing any other Arrow - 0 marks.

4. (2+2+2+2=8 marks) Draw three different NFAs and one DFA for the regular expression $(11111+111)^*$, assume $\Sigma = \{1\}$.

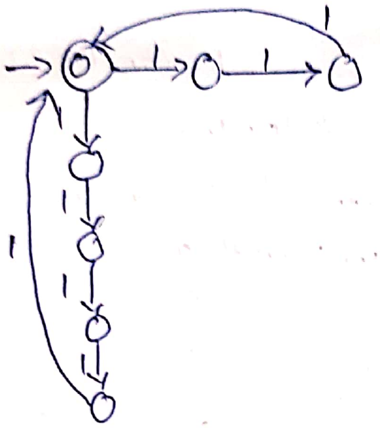
2 NFA1



NFA3 2



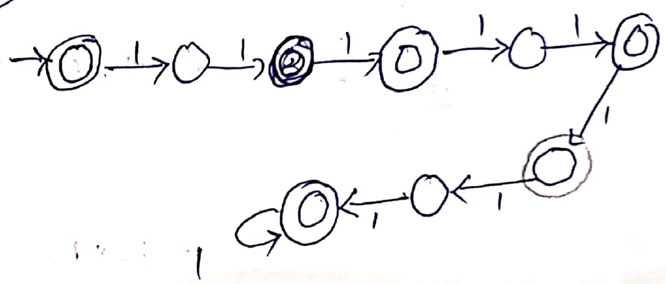
NFA2



2

DFA1

2



5. (2+2=4 marks) Let $\Sigma = \{1, 2, 3\}$. How many different 5-state DFAs are possible. What about 5-state NFAs. Justify your answer.

2

DFA

$Q \times \Sigma \to Q$

Fns : $5 \times 3 \to 5$

$= 5^{5\times3} = 5^{15}$.

possibilities for the start state $= 5$

(Any state could be a start st)

poss for the final state 2

(Any subset)

$= 2^5$

DFAs : $5^{15} \times 5 \times 2^5$

2

NFA

$Q \times \Sigma \to 2^Q$

Fns : $5\times3 \to 2^5$

: $(2^5)^{15}$

NFAs : $(2^5)^{15} \times 5 \times 2^5$

6. (2 marks) The regular expression for $L = \{x \mid x \in \Sigma^* \text{ such that the length of } x \text{ is odd }\}$, $\Sigma = \{0,1\}$

1+1

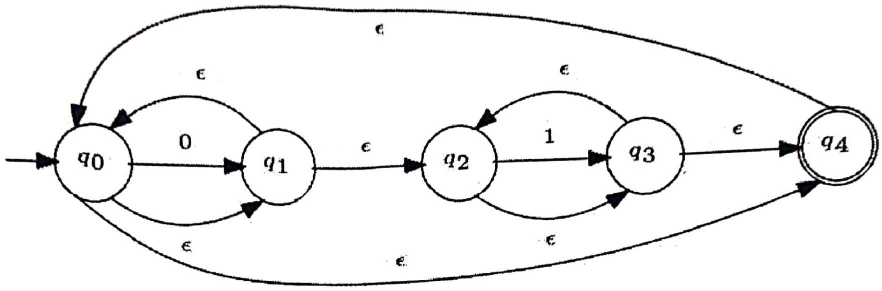
ODD length String begins with 0 or 1 followed by Even length String over {0,1}

Answer$_1$: $(0+1)[00+01+10+11]^*$

Answer$_2$: $(0+1)[(0+1)(0+1)]^*$ ← Even length.

Answer$_3$: $0[(0+1)(0+1)]^* + 1[(0+1)(0+1)]^*$.

7. (3+2=5 marks) For the ϵ-NFA as illustrated below, find the ϵ-closure. Also, find the equivalent NFA.



3 marks.

ε-closure

$E(q_0) = \{q_0, q_1, q_2, q_3, q_4\}$

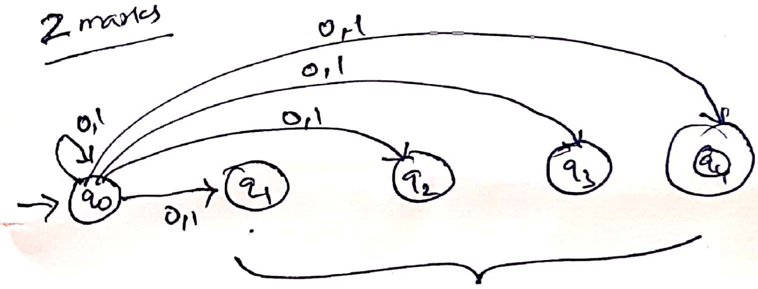
$E(q_1) = \{q_1, q_0, q_2, q_3, q_4\}$

$E(q_2) = \{q_0, q_1, q_2, q_3, q_4\}$

$E(q_3) =$ "

$E(q_4) =$ "

2 marks



$\forall q_i \quad 1 \le i \le 4$

$q_i \xrightarrow{0} q_j \quad 0 \le j \le 4$

$q_i \xrightarrow{1} q_j \quad 0 \le j \le 4$

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