CSE 331: Automata & Computability
Spring 2025
Prepared By: KKP
Assignment 01 (DFA & NFA)
Total Mark: 103

[Or means you may solve any One question]
[Problems having multiple Or, mention the problem no properly. For example: 2a) 3b)]

Group Formation:

- This is a group assignment. You can make a group of **at most three students**.
- From each group you have to submit one copy only.
- Cross section group formation is not allowed.

Submission Deadline:

- Part A (Questions 1-10): February 18, 2024
- Part B (Questions 11-21): February 25, 2024
- Part C (Questions 01-04): March 2, 2025

Submission Link: https://forms.gle/pjZc6uuqFrPXBCDG8
Please note you have to submit both a hard copy and a soft copy. If you are unable to submit the hard copy within the deadline, you may submit the soft copy by the deadline and later [by next class] submit the hard copy.

Penalty:

- For each day delay, you will receive a 5 marks penalty.
- If you plagiarize, then each member of the group will receive (number of questions plagiarized * 3 * number of group members) points penalty.

Additional Resources

Please go through the video lectures of Mursalin Sir [**The first three video lectures on DFA**]
Link: https://drive.google.com/drive/folders/179OApcX9k_8GBFM3Suea1_SEwTpyReRW

Part 0:

1. Do you understand that it is not possible to finish the assignment if you start solving the assignment 1-2 days before the deadline? (Yes/No)

2. Do you understand solving the assignment using AI or directly copy pasting from any available resources without understanding the solution will impact your quiz/midterm performance? (Yes/No)

Part A: Deterministic Finite Automata (DFA) [Each question contains 3 marks]

1. a) Draw a DFA for the set of strings that have three consecutive 0s. $\Sigma = \{0,1\}$

   Or, b) Draw a DFA for the set of strings that don't contain 000. $\Sigma = \{0,1\}$

2. a) Construct a DFA that accept the language, L = { w ∈ $\{a,b\}^*$: w starts and ends with different symbols.}

   Or, b) Construct a DFA that accepts the language, L = { w ∈ $\{a,b\}^*$: w starts and ends with the same symbol.}

3. a) Draw a DFA of strings that ends with "0101". $\Sigma = \{0,1\}$

   Or, b) Design a DFA that accepts the language L = {w | w ends with the substring "yxxy"} over the alphabet $\{x,y\}$

4. a) Construct a DFA defined as L = { w ∈ $\{0,1\}^*$: the length of w is two more than multiple of four}

   Or, b) Construct a DFA defined as L = { w ∈ $\{0,1\}^*$: numbers of 1s in w is two more than multiple of four}

5. Construct a DFA defined as L = { w ∈ {0,1}*: w, when interpreted as a binary number, is divisible by 5.}

6. a) L = {w ∈ $\{0, 1, \#\}^*$: w does not contain # and the number of 0s in w is not a multiple of 3}

   Or, b) let's $\Sigma = \{0,1\}$

   L1 = {w does't contain #}

   L2 = {the number of 0s in w is not a multiple of 3}

   L = L1 ∩ L2

   Prove L is a regular language by giving a state diagram for DFA.

7. Construct a DFA of the language *L* over the alphabet $\Sigma = \{a,b,c\}$ defined as follows-

   L = { w|w does not contain "ba" and ends with "cb"}

8. Draw a DFA of strings that contains at least three 0s or exactly two 1s. ∑= {0,1}

9. a) Draw a DFA of strings where the 2nd last symbol is a. ∑= {a,b}

   Or, b) Draw a DFA of strings where the 3rd last symbol is 1. ∑= {0,1} [You may draw the NFA for this problem if you find it difficult to solve using DFA]

10. L = {w ∈ $\{a, b\}^*$: the last letter of w appears at least twice in w.}

Part B: More Deterministic Finite Automata (DFA) [Each question contains 3 marks]

11. a) Draw a DFA of strings that have 1 as every 3rd symbol. ∑= {0,1}

    Or, b) The set of binary numbers has 0 in all even positions. Σ={0,1}.

12. a) Draw a DFA that accepts exactly one “ab”. Σ = {a,b}

    Or, b) Draw a DFA that accepts exactly two “ab”. Σ = {a,b}

13. Draw a DFA that accepts at least two “00” as a substring. Σ = {0,1}

14. a) Draw a DFA that accepts exactly two “00” as a substring. Σ = {0,1}

    Or, b) Draw a DFA that accepts at most two “00” as a substring. Σ = {0,1}

15. Construct a DFA defined as L = {An even number of 0s follow the last 1 in w} Σ = {0,1}

16. Construct a DFA defined as L = {w| each “b” is followed by at least one “a”} Σ = {a,b}
    For example: baaa

17. Construct a DFA where the set of binary strings where numbers of 0s between two successive 1s will be even. Σ = {0,1}.

18. Construct a DFA of the Language, L = { w ∈ $\{0,1\}^*$: no 00 appears as a substring before the first 11 in w.}

19. Construct a DFA of the Language, L = { w ∈ $\{0,1\}^*$: no 00 appears as a subsequence before the first 11 in w.}

20. a) Construct a DFA of the Language, L = { w ∈ $\{0,1\}^*$: w contains 01^m0 as a substring where m is divisible by 3 }

Or, b) Construct a DFA of the Language, L = { w ∈ $\{0,1\}^*$: w contains 01^m0 as a substring where m leaves a remainder of 2 when divided by 3}

Hints:

We denote by 1^m the string $\underbrace{111\ldots111}_{m \text{ times}}$.

21. a) Construct a DFA of the Language, L = { w ∈ $\{0,1\}^*$: w = 0^m1^n where m and n are both odd.}

Or, b) Construct a DFA of the Language, L = { w ∈ $\{0,1\}^*$: w = 0^m1^n where m and n are both even.}

Or, c) The problem can also be designed as:

L1 = {w : w = 0^m, where m is even}
L2 = {w : w = 1^n, where n is even}
L = L1 . L2

Prove L is a regular language by giving a state diagram for DFA.

Part C: Mursalin Sir's [MHB] Quiz Question from Previous semesters [Each question contains 10 marks.]

Question 1.

Let Σ = {0, 1}
L1 = {w : w = 1^m where m is odd}
L2 = {w : w does not contain any y ∈ L1 as a substring}

(a) Write down a length 6 string that is in L2. (1 point) .
(b) Give the state diagram for a DFA that recognizes L1. (5 points)
(c) Give the state diagram for a DFA that recognizes L2. (3 points)
(d) Give the state diagram for a DFA that recognizes L1 ∩ L2. You can use the construction shown in class but there is a much simpler DFA. (2 points)

Question 2.

The symmetric difference of the languages L1 and L2, denoted by L1$\triangle$L2, is defined in the following way.

$$L1 \triangle L2 = \{w : w \text{ is in exactly one of L1 and L2}\}$$

Let $\Sigma = \{0, 1\}$. Consider the following languages over Σ.

A = {w : the length of w is greater than or equal to 3 but less than or equal to 5}
B = {w : the length of w is greater than or equal to 2 but less than or equal to 4}
C = {w : the length of w is odd}

(a) Give the state diagram for a DFA that recognizes A. (2 points)
(b) Give the state diagram for a DFA that recognizes B. (2 points)
(c) Give the state diagram for a DFA that recognizes A$\triangle$B. (2 points)
(d) If you use the construction from class to get a DFA for the language $(A\triangle B) \cup C$, how many states will it have? (1 point)
(e) Give a 5-state DFA that recognizes $(A\triangle B) \cup C$. (3 points)

Question 3.

Let $\Sigma = \{0, 1\}$. Consider the following languages over Σ.

L1 = {w : every second letter of w is 0}
L2 = {w : every third letter of w is 1}

(a) Write down a length 5 string that is in $L1 \cap L2$. (1 point) .
(b) Give the state diagram for a DFA that recognizes L1. (3 points)
(c) Give the state diagram for a DFA that recognizes L2. (3 points)
(d) Give the state diagram for a DFA that recognizes $L1 \cap L2$. (3 points)

Question 4.

Let $\Sigma = \{0, 1\}$. Consider the following languages over Σ.

$$L1 = \{0, 10\}$$
$$L2 = L_1^*$$
$$L3 = \{w : \text{the length of w is four}\}$$

(a) Write down all the strings in L2 ∩ L3. (2.5 points)
(b) Give the state diagram for a DFA that recognizes L1. (4.5 points)
(c) Give the state diagram for a DFA that recognizes L2. (3 points)

For Practice: [Don't have to submit]

Part D: Non-Deterministic finite automata (NFA)

1. Construct an NFA that recognizes the language L = { w $\in \{0,1\}^*$: w contains both "000" and "111" as a substring}

2. Construct a NFA which recognize the language L = { w $\in \{0,1\}^*$: w contains at least two 0s or exactly two 1s}

3. Construct an NFA for the languages L = {w $\in \Sigma$: w does not start with a Punctuation or contains only Alphabets} where Σ = D U A U P

   Digit, D = {0,1,2,3,4,5,6,7,8,9}
   Alphabet, A = {a, b, c,........., x, y, z}
   Punctuation, P = {*,#}

   You can use the sets above to label the transitions of your NFA.