CSE 331: Automata & Computability
Spring 2025
Prepared By: KKP
Assignment 01 (DFA & NFA)
Total Mark: 122

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 1-12): October 20, 2025
- Part B (Questions 13-24): October 26, 2025
- Part C (Questions 01-05): November 3, 2025

Submission Link:

- Part A (Questions 1-12): **Link**
- Part B (Questions 13-24): **Link**
- Part C (Questions 01-05): **Link**

Please note that 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 the 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

Some common FAQs:

For questions with "or," do I need to solve all of them?

- No. If there are multiple options for a question, you may solve any one of them. For problems with multiple "or" options, please mention the specific problem number properly. For example: 2a), 3b).

Do I need to stay in the same group for all assignments or assignment parts?
- No. You may change your group, but make sure to inform your group members.

I couldn't find any group members. Can I get an extension on the deadline?
- No. Doing the assignment in a group is optional. In previous semesters, some students completed and submitted the assignment individually within the deadline. Even if you don't find any group members you should start doing the assignment.

I enrolled in the course late / missed the first few classes. Can I get an extension on the deadline?
- No. Quizzes and other exams will be held on time. You are expected to keep up with the course pace to perform well.

Suggestions:
While completing the assignment, please remember the following things that may help you gain maximum benefit.

1. Make sure you understand the solution you are writing. Don't blindly copy and paste from any sources. It will be a waste of time, nothing else.
2. If you divide the tasks among the group members, please make sure the other group members verify the solution. Also, help your group mates if they face difficulty understanding any problem.
3. For plagiarism, you will receive a penalty.
4. Start your assignment at the earliest possible time. You will be penalized for each day of late submission.

Part 0: Self Assesment

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 that solving the assignment using AI or directly copying and 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. Draw a DFA for a language that recognizes the set of strings that don't have three consecutive 0s. $\sum = \{0,1\}$

2. $L = \{ w \in \{a,b,c\}^* : w$ contains bbac as a subsequence$\}$.

[Do you understand the difference between a substring and a subsequence?]

3. a) Construct a DFA that accepts 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.}

4. a) Draw a DFA for a language that recognizes the set of strings ending with "0101". ∑= {0,1}

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

5. a) Construct a DFA defined as L = { w ∈ {0,1}*: the length of w is two more than a 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}

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

7. 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 ∑= {0,1}
   L1 = {w does not 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 a DFA.

   → **Do you think 7a and 7b are the same Question?**

8. Construct a DFA of the language *L* over the alphabet Σ={*a*,*b*,*c*} defined as follows-
   L = { w|w does not contain "ba" and ends with "cb"}

9. Draw a DFA for a language that recognizes the set of strings that contains at least three 0s or exactly two 1s. ∑= {0,1}

10. a) Draw a DFA for a language that recognizes the set 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]

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

12. L = { w ∈ {0,1}* : the difference between the number of 0s and the number of 1s in w is a multiple of three }

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

13. 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}.

14. 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}

15. Draw a DFA that accepts at least two "00" as a substring. Σ = {0,1}

16. 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}

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

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

19. Construct a DFA where the set of binary strings where the number of 0s between two successive 1s is even. Σ = {0,1}.

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

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

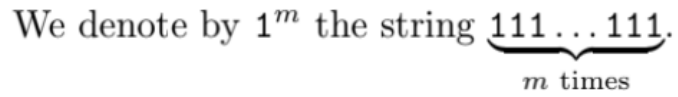
22. L = { w ∈ {0,1}* : w contains even numbers of 1s between last two 0s}

23. 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:



24. 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.]

Note: These questions were solved by your seniors during their quiz (20-25 minutes). The midterm questions will be similar to this pattern.

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△L2, is defined in the following way.

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

Let Σ = {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△B. (2 points)
(d) If you use the construction from class to get a DFA for the language (A△B)∪ C, how many states will it have? (1 point)
(e) Give a 5-state DFA that recognizes (A△B) ∪ C. (3 points)

Question 3.

Let Σ = {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 ∩ 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 ∩ L2. (3 points)

Question 4.

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

L1 = {0, 10}

$L2 = L_1^*$

L3 = {w : 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)

Question 5. [Previous Midterm Question]

Let Σ = {a, b}. Consider the following languages over Σ.

L1 = {w : every even position letter in w is the same as the first letter of w}
L2 = {w : every 2k + 1 position in w is a, where k ≥ 0 }
L3 = {w : every 2k + 1 position in w is b, where k ≥ 0 }
L4 = L1 ∩ (L2 ∪ L3)

(a) Give the state diagram for a DFA that recognizes L1. (3 points)
(b) Give the state diagram for a DFA that recognizes L2. (3 points)
(c) Find all four-letter strings L4. (1 point)
(d) Give the state diagram for a DFA that recognizes L4 using only four states. (2 points)
(e) Is $\overline{L2} \circ L3 = \overline{L2}$? Give justification for your answer. (1 point)

For Practice: [Don't have to submit]

Part D: Non-Deterministic finite automata (NFA)

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

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

3. Construct an NFA for the languages L = {w ∈ Σ: 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.