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. $\sum = \{0,1\}$

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

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". $\sum = \{0,1\}$

   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 $\sum = \{0,1\}$
   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 Σ={*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. $\sum = \{0,1\}$

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

   Or, b) Draw a DFA of strings where the 3rd last symbol is 1. $\sum = \{0,1\}$ [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. $\Sigma = \{0,1\}$

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

12. a) Draw a DFA that accepts exactly one "ab". $\Sigma = \{a,b\}$

    Or, b) Draw a DFA that accepts exactly two "ab". $\Sigma = \{a,b\}$

13. Draw a DFA that accepts at least two "00" as a substring. $\Sigma = \{0,1\}$

14. a) Draw a DFA that accepts exactly two "00" as a substring. $\Sigma = \{0,1\}$

    Or, b) Draw a DFA that accepts at most two "00" as a substring. $\Sigma = \{0,1\}$

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

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

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

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

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

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

    Or, b) Construct a DFA of the Language, $L = \{ w \in \{0,1\}^*$: 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 4.

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

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

(a) Write down all the strings in $L2 \cap L3$. (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 $\Sigma = D \cup A \cup P$

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.