1. Extended definition of Regular Language.

2. Write the strings that the following Regular Expressions will generate:

1. (0+1)*	5. (0*1*)*	9. a (0+1) b
2. 0+1	6. (01*)*	10. a (0+1)* b
3. (00)*	7. 0*1* + (ab)*	11. (a (0+1)* b)*
4. 0*1*	8. (0*1* + (ab)*)*	12. ab + 1*01*

3. Is (0+1)* and (0*1*)* the same? Justify your answer.

4. Write the shortest string that will be generated by this regular expression –
   a. aa*b (0+1) + 1*0 (baa*)
   b. (0+1) 1 (00 + 0(11)* + 100) + 1* (00 (010 + 01*0)) 01

5. Construct a Regular Expression that generates the Language L = { w ∈ {0,1}*: w contains "101" as a substring.}

6. Construct a Regular Expression that generates the Language L = { w ∈ {0,1}*: w starts with "101".}

7. Construct a Regular Expression that generates the Language L = { w ∈ {0,1}*: w ends with "101".}

8. Construct a Regular Expression that generates the Language L = { w ∈ {0,1}*: w doesn't start with "1".}

9.

   a. Construct a Regular Expression that generates the Language L1 = { w ∈ {0,1}*: w contains "00" or "11".}

   b. Construct a Regular Expression that generates the Language L2 = { w ∈ {0,1}*: w contains "00" and "11".}

   c. Construct a regular expression for $\overline{L1}$

   d. Construct a regular expression for $\overline{L2}$

10.

   a. Construct a Regular Expression that generates the Language L = { w ∈ {0,1}*: w contains exactly two 1s.}
   b. For the previous question, your three friends write three different solutions.
      (0+1)* 1 (0+1)* 1 (0+1)*, (0+1)* 1 0* 1 0* and 0* 1 0* 1 (0+1)*
      Find the correct solution.

11. Construct a Regular Expression that generates the Language L = { w ∈ {0,1}*: w contains at least two 1s.}
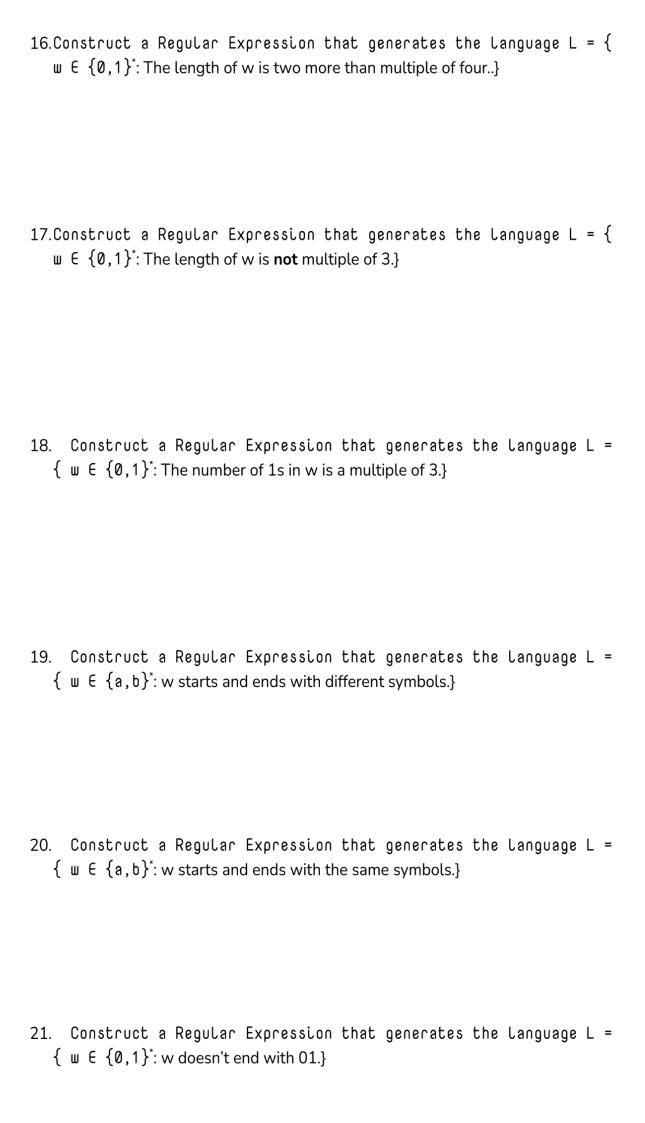
12.

    a. Construct a Regular Expression that generates the language $L = \{ w \in \{0,1\}^* : w$ contains at most two 1s.$\}$

    b. Your friend claims that one of the correct regular expressions for the previous question is 0* (0+1) 0* (0+1) 0* + ε. Do you agree or disagree?

13.

    a. Construct a Regular Expression that generates the language $L = \{ w \in \{0,1\}^* :$ The length of w is even or multiple of 2.$\}$

    b. Your friend claims that one of the correct regular expressions for the previous question is (00)* + (01)* + (10)* + (11)*. Do you agree or disagree?

14. Construct a Regular Expression that generates the language $L = \{ w \in \{0,1\}^* :$ The length of w is odd.$\}$

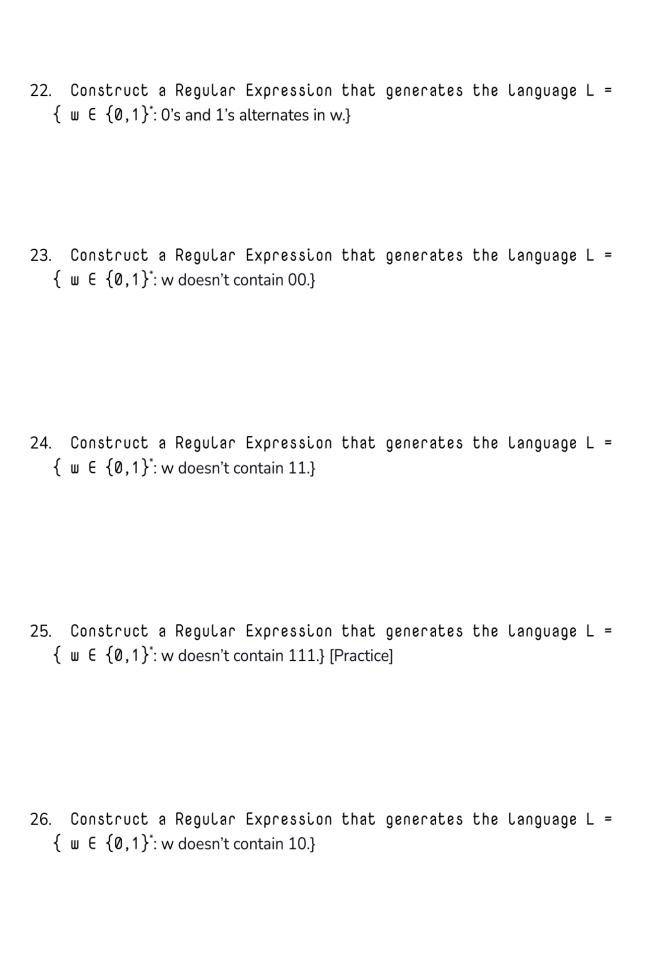15. Construct a Regular Expression that generates the language $L = \{ w \in \{0,1\}^* :$ The length of w is multiple of 3.$\}$

16. Construct a Regular Expression that generates the Language L = { w ∈ {0,1}*: The length of w is two more than multiple of four..}

17. Construct a Regular Expression that generates the Language L = { w ∈ {0,1}*: The length of w is **not** multiple of 3.}

18. Construct a Regular Expression that generates the Language L = { w ∈ {0,1}*: The number of 1s in w is a multiple of 3.}

19. Construct a Regular Expression that generates the Language L = { w ∈ {a,b}*: w starts and ends with different symbols.}

20. Construct a Regular Expression that generates the Language L = { w ∈ {a,b}*: w starts and ends with the same symbols.}

21. Construct a Regular Expression that generates the Language L = { w ∈ {0,1}*: w doesn't end with 01.}

22. Construct a Regular Expression that generates the Language L = { w ∈ {0,1}*: 0's and 1's alternates in w.}

23. Construct a Regular Expression that generates the Language L = { w ∈ {0,1}*: w doesn't contain 00.}

24. Construct a Regular Expression that generates the Language L = { w ∈ {0,1}*: w doesn't contain 11.}

25. Construct a Regular Expression that generates the Language L = { w ∈ {0,1}*: w doesn't contain 111.} [Practice]

26. Construct a Regular Expression that generates the Language L = { w ∈ {0,1}*: w doesn't contain 10.}

27. Construct a Regular Expression that generates the Language L = { w ∈ {0,1}*: w doesn't contain 00 and 11.} Or, **Similar to Question:**

28.

a) Construct a Regular Expression that generates the language L = { w ∈ {0,1}*: w contains 0 in every third position.}

b) Regular language for $\overline{L}$

29.

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

$$L_1 = \{w : w \text{ does not contain } 11\}$$
$$L_2 = \{w : \text{every } 1 \text{ in } w \text{ is followed by at least one } 0\}$$
$$L_3 = \{w : \text{the number of times } 1 \text{ appears in } w \text{ is even}\}$$

Now solve the following problems.

(a) **Give** a regular expression for the language L_1. (2 points)

(b) Your friend claims that $L_1 = L_2$. **Prove** her wrong by writing down a five-letter string in $L_1 \setminus L_2$. Recall that $L_1 \setminus L_2$ contains all strings that are in L_1 but not in L_2. (2 points)

(c) **Give** a regular expression for the language $L_1 \setminus L_2$. (2 points)

(d) **Give** a regular expression for the language L_3. (2 points)

(e) **Give** a regular expression for the language $L_2 \setminus L_3$. (2 points)