Team Members:

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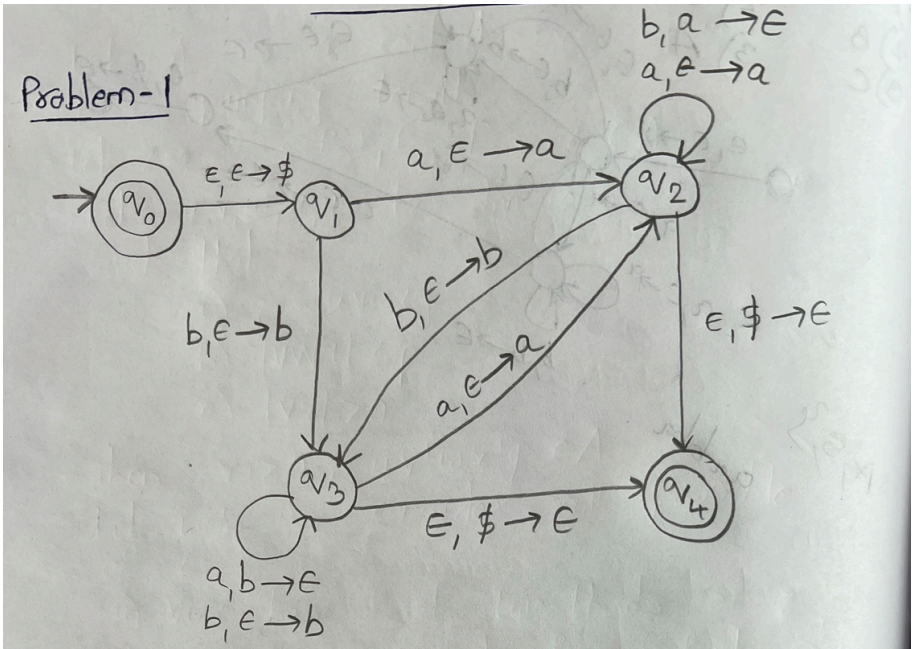
Problem 1.



Explanation:

1- Empty string is also part of string. So, q_0 is also a final state

2- If 'a' is first character of string, we add it to stack & repeatedly do it for all a's & pop a's from stack whenever we see a 'b'.

3- If 'b' is first character, same as (2) but push b for 'b', pop b for 'a'

4- There is a case where for example abababba. Here, abab is in pattern where 'a' comes before 'b'. ba is in pattern where 'b' comes before 'a'. But, string is part of language. So, from q_2 on 'b' we have one more transition by popping nothing, but adding 'b' to stack.

5- Same as (4) for q_3 on 'a'

Problem 2.

Problem-2

- Let B is a context free grammar with p as pumping length.
- Let $z = 0^p 1^p 1^p 0^p$. Since z is a palindrome, $z \in B$.
- Let u, v, w, x, y are divisions of z such that
  a) $z = uvwxy$
  b) $|vx| > 0$
  c) $|vwx| \leq p$
- Then, $\forall i \geq 0$, $uv^i wx^i y \in B$
- Let, $i = 2$, i.e; $z' = uv^2wx^2y$
- Let us consider all possible divisions of z.
  a) v, x has only 0's. Then uv^2wx^2y has more 0's than 1's. So, $z' \notin B$
  b) v, x has only 1's. Then, uv^2wx^2y has more 1's. So, $z' \notin B$
  c) v, x has symbols of opposite kinds. then, uv^2wx^2y is not a palindrome. So, $z' \notin B$
  d) v, x has both 0's & 1's. This is not possible since, $|vwx| \leq p$.

∴ B doesn't satisfy pumping lemma. Therefore, B is not context-free grammar.

Problem 3.

Problem-3

- Let A is a context-free grammar with p as pumping length.
- Let $z = 0^{2p}0^p1^p0^{2p}$. $z \in A$
- Let u, v, w, x, y be divisions of z such that
  a) $z = uvwxy$
  b) $|uwx| \leq p$
  c) $|vx| > 0$
- Then, $\forall i \geq 0$, $uv^iwx^iy \in A$
- Let us consider all possible divisions of z.
  a) ~~case has first ... of z~~
  a) vwx has 0's only from first 0^{2p}. Then $uv^2wx^2y \notin A$ since it has more 0's in front than at last.
  b) vwx has 0's from $0^{2p}0^p$. Then, $uv^2wx^2y \notin A$ since, length of first part is not equal to length of middle part.
  c) vwx has only 1's. Then, $uv^2wx^2y \notin A$, since length of first part is not equal to length of middle part.
  d) vwx has same 0's & 1's. Then, $uv^2wx^2y \notin A$ with reason same as above.
  e) vwx has some 1's & then 0's, ie, e 1's from 1^p & 0's from 0^{2p}. Then, $uv^2wx^2y \notin A$ since, number of 0's in front doesn't match one's in last.

f) vwx has 0's only from last 0^{2p}
then $uv^2wx^2y \notin A$ since it has less 0s in front than at last.

∴ A doesn't satisfy pumping lemma. Therefore, A is not context free grammar