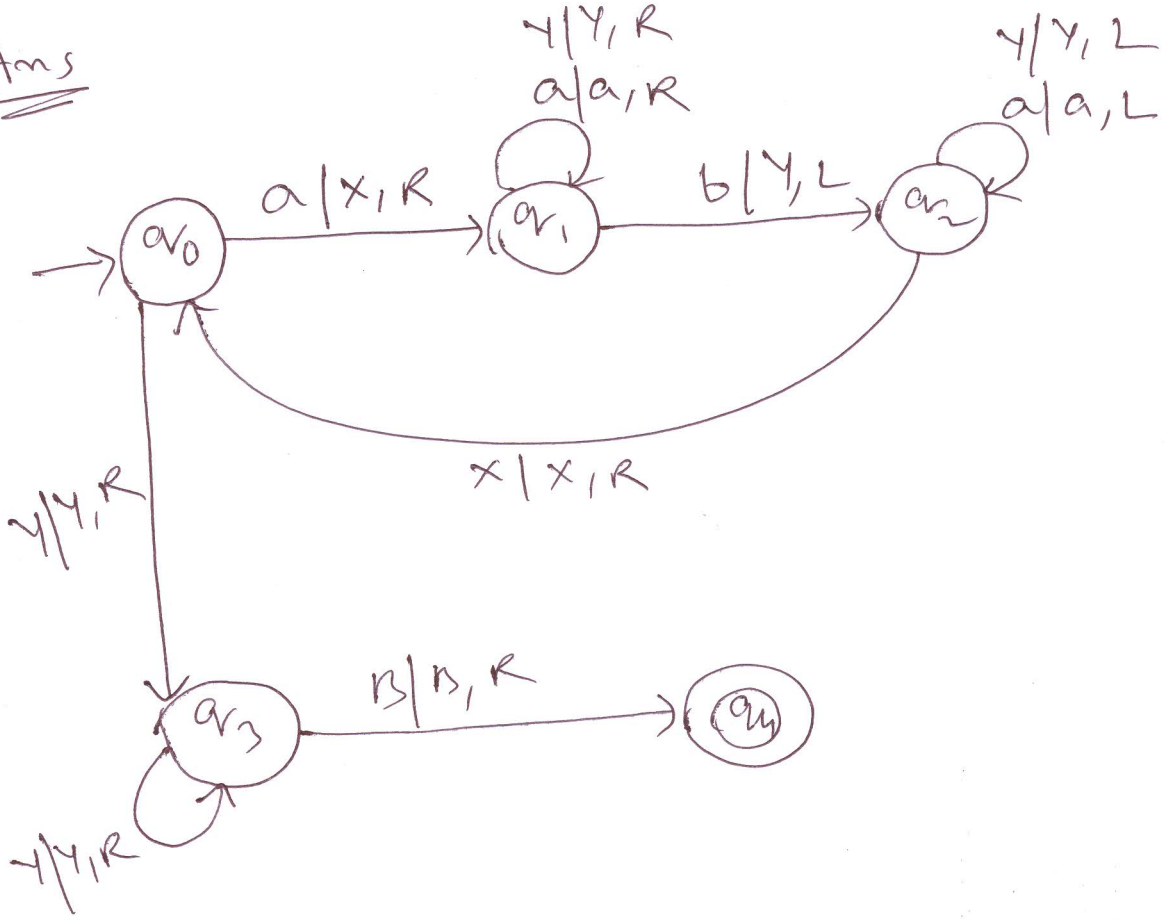
Problems on TM

Q. Design a TM for $L = \{a^n b^n \mid n \geq 1\}$ & show the ID for $w = aabb$

Ans



Transition functions

① $\delta(q_0, a) = (q_1, X, R)$

② $\delta(q_1, a) = (q_1, a, R)$

③ $\delta(q_1, Y) = (q_1, Y, R)$

④ $\delta(q_1, b) = (q_2, Y, L)$

⑤ $\delta(q_2, a) = (q_2, a, L)$

⑥ $\delta(q_2, Y) = (q_2, Y, L)$

⑦ $\delta(q_2, X) = (q_0, X, R)$

⑧ $\delta(q_0, Y) = (q_3, Y, R)$

⑨ $\delta(q_3, Y) = (q_3, Y, R)$

⑩ $\delta(q_3, B) = (q_4, B, R)$

ID for $w = aabb$

$q_0, aabbB \vdash X q_1 abbB \vdash Xa q_1 bbB$

$\vdash Xa q_2 aYbB \vdash a q_2 XaYbB \vdash X q_0 aYbB$

$\vdash XX q_1 YbB \vdash XXY q_1 bB \vdash XX q_2 YYB$

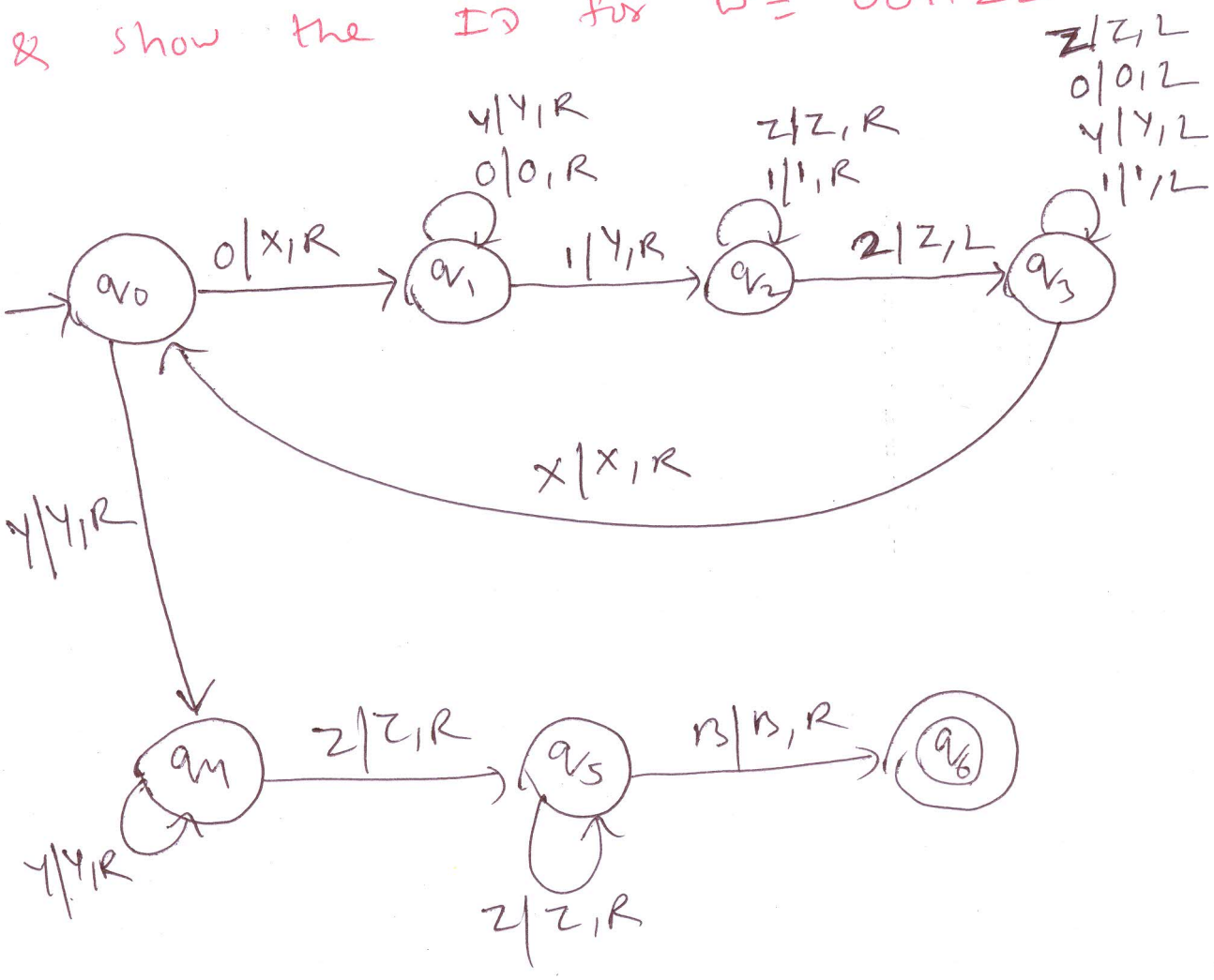
$\vdash X q_2 XYYB \vdash XX q_0 YYB$

$\vdash XXY q_3 YB \vdash XXYY q_3 B \vdash XXYYB q_4$

Accepted

Q. Design a TM for $L = \{ 0^n 1^n 2^n \mid n \geq 1 \}$

& show the ID for $w = 001122$



Note: See the diagram & write the transition function. ~~For~~ For every design transition diagram & transition function, both required.

Q. Design a TM for $L = \{ w \mid w$ is a palindrome & $w \in \{a,b\}^* \}$

Ans

Palindrome

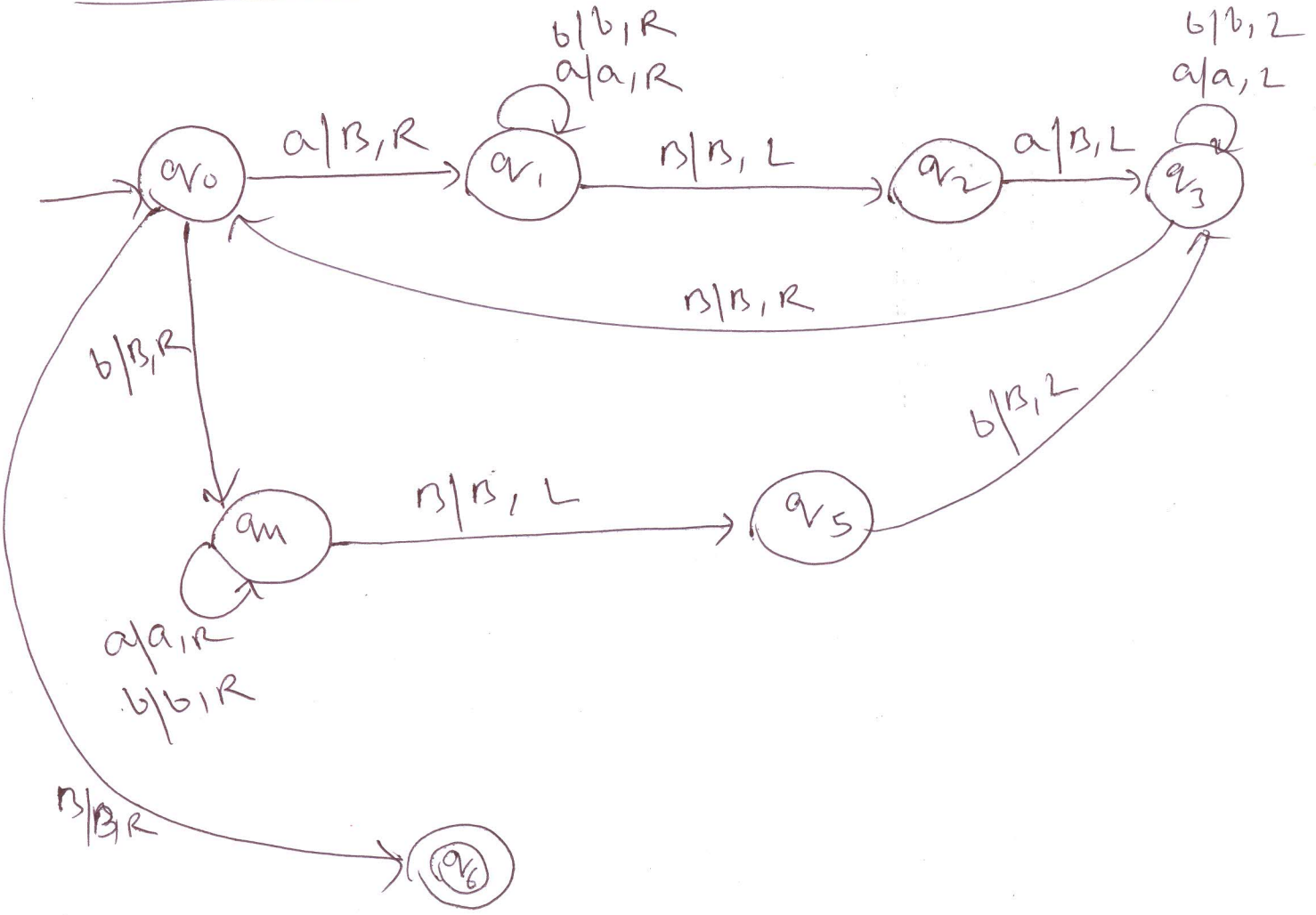
Even Palindrome

Odd Palindrome

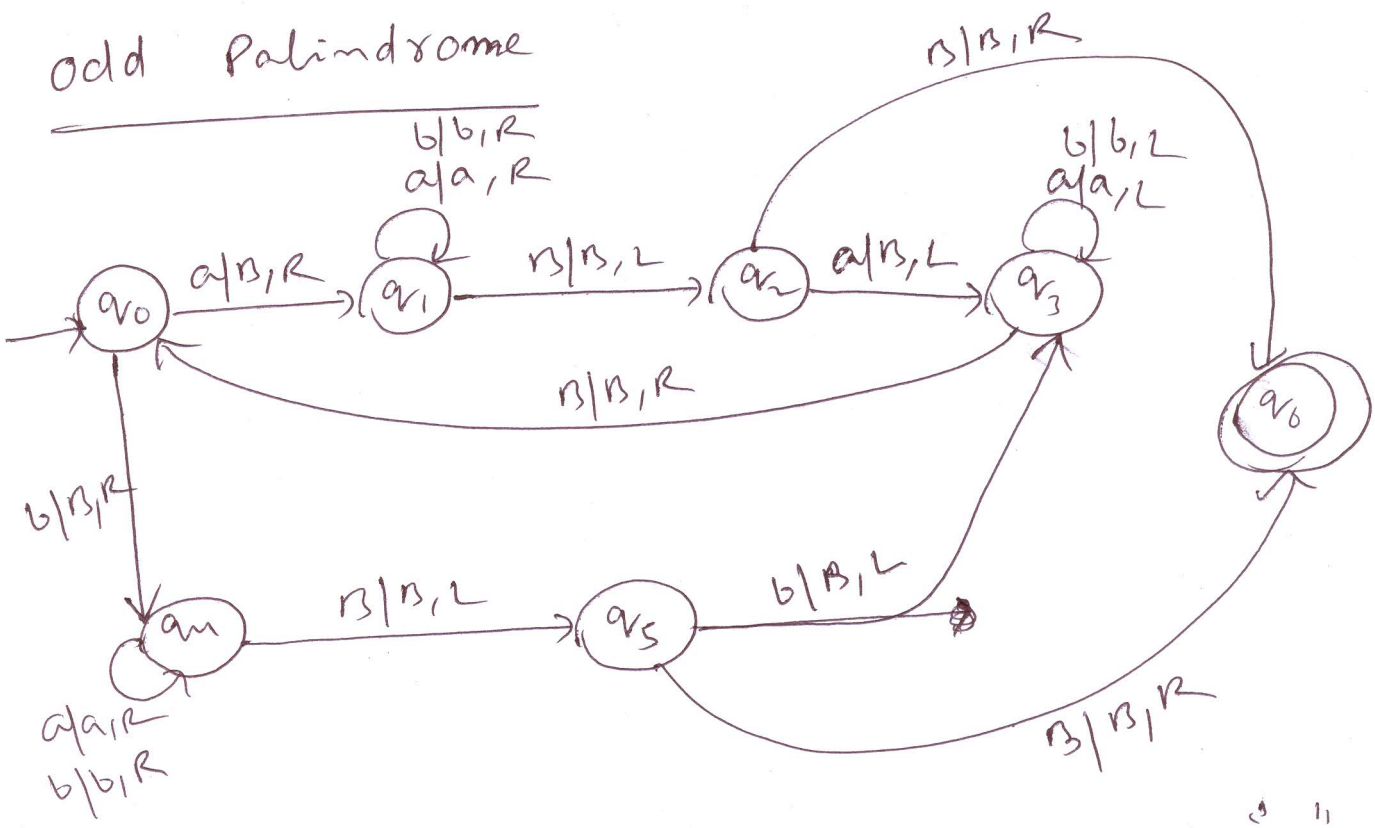
Or the language $L = \{ ww^R \mid w \in \{a,b\}^* \}$

It means it is even palindrome.

TM for even palindrome



Odd Palindrome

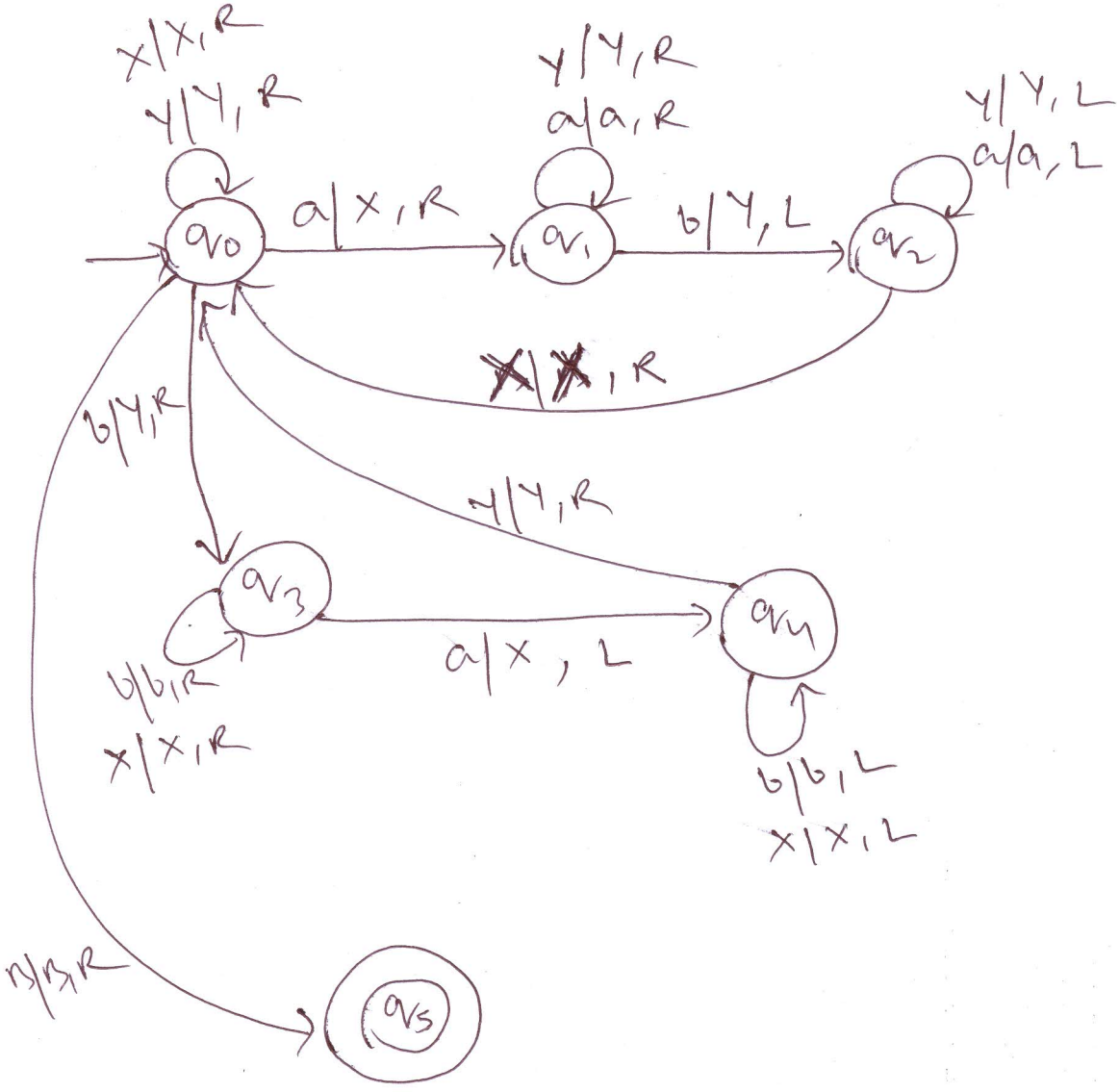


Note :- If the middle symbol is "a" & it is odd palindrome then from q_2 it'll go to final state on blank "B".

If it is "b", then from q_5 it'll go to final state.

→ Final answer for palindrome is combination of above two diagrams (even & odd).

Q. Design a TM for $L = \{w \mid w \in \{a,b\}^* \text{ \& } N_a(w) = N_b(w)\}$



Transition functions

1. $\delta(q_0, a) = (q_1, X, R)$
2. $\delta(q_1, a) = (q_1, a, R)$
3. $\delta(q_1, Y) = (q_1, Y, R)$
4. $\delta(q_1, b) = (q_2, Y, L)$
5. $\delta(q_2, a) = (q_2, a, L)$
6. $\delta(q_2, Y) = (q_2, Y, L)$
7. $\delta(q_2, X) = (q_0, X, R)$
8. $\delta(q_0, Y) = (q_0, Y, R)$
9. $\delta(q_0, X) = (q_0, X, R)$
10. $\delta(q_0, b) = (q_3, Y, R)$
11. $\delta(q_3, b) = (q_3, b, R)$
12. $\delta(q_3, X) = (q_3, X, R)$
13. $\delta(q_3, a) = (q_4, X, L)$
14. $\delta(q_4, b) = (q_4, b, L)$
15. $\delta(q_4, X) = (q_4, X, L)$

(16) $\delta(q_4, Y) = (q_0, Y, R)$

(17) $\delta(q_0, B) = (q_5, B, R)$

ID for $w = abab$

$q_0 abab B \vdash X q_1 bab B \vdash q_2 X Y ab B \vdash X q_0 Y ab B$

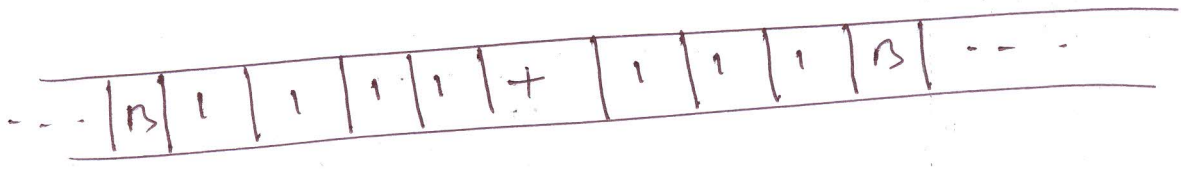
$\vdash X Y q_0 ab B \vdash X Y X q_1 b B \vdash X Y q_2 X Y B$

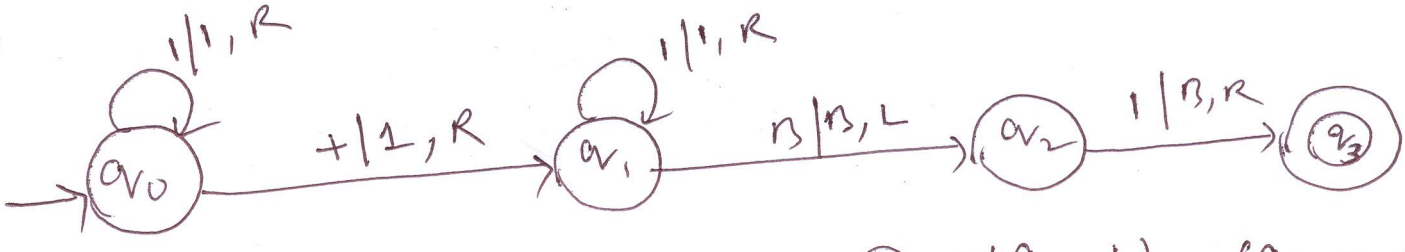
$\vdash X Y X q_0 Y B \vdash X Y X Y q_0 B \vdash X Y X Y B q_5$

Accepted

Q. Design a TM for addition of two integers.

Ex: $a = 4$ $b = 3$, Each number will be represented by unary ~~alt~~ form. so $a+b$ will be stored as





(1) $\delta(q_0, 1) = (q_0, 1, R)$

(2) $\delta(q_0, +) = (q_1, 1, R)$

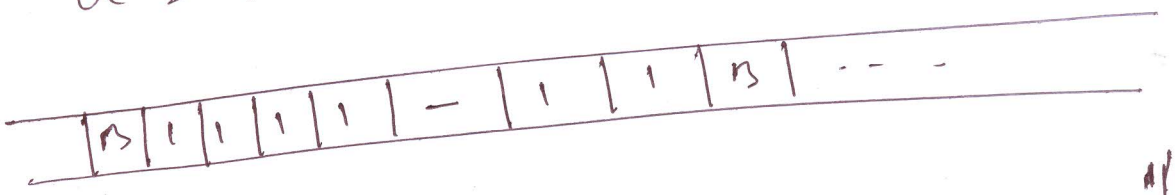
(3) $\delta(q_1, 1) = (q_1, 1, R)$

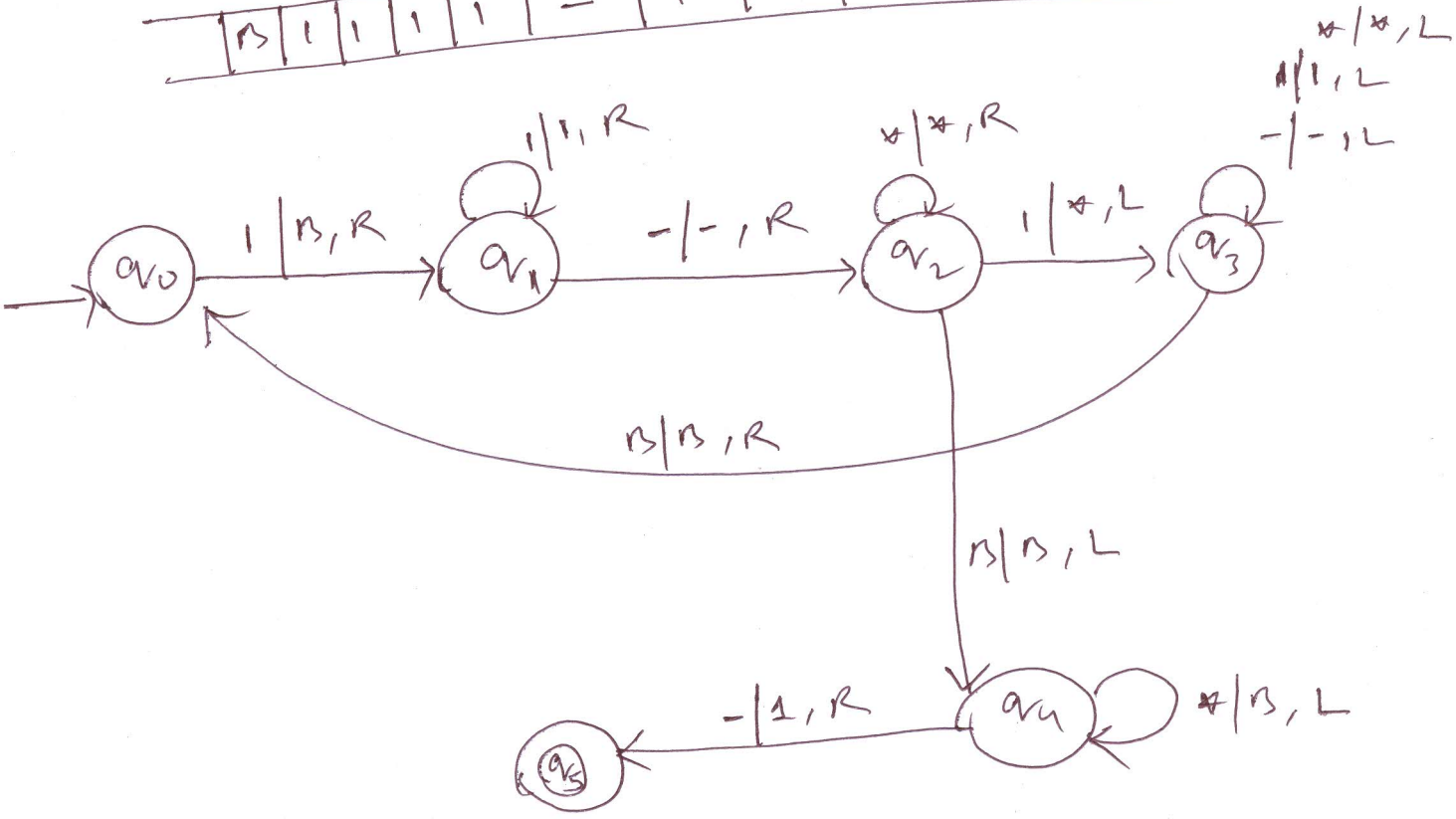
(4) $\delta(q_1, B) = (q_2, B, L)$

(5) $\delta(q_2, 1) = (q_3, B, R)$

Q. Design a TM for subtraction of two integers where $a > b$.

Ex $a = 4$ $b = 2$





① $\delta(q_0, 1) = (q_1, B, R)$

② $\delta(q_1, 1) = (q_1, 1, R)$

③ $\delta(q_1, -) = (q_2, -, R)$

④ $\delta(q_2, *) = (q_2, *, R)$

⑤ $\delta(q_2, 1) = (q_3, *, L)$

⑥ $\delta(q_3, -) = (q_3, -, L)$

⑦ $\delta(q_3, 1) = (q_3, 1, L)$

⑧ $\delta(q_3, *) = (q_3, *, L)$

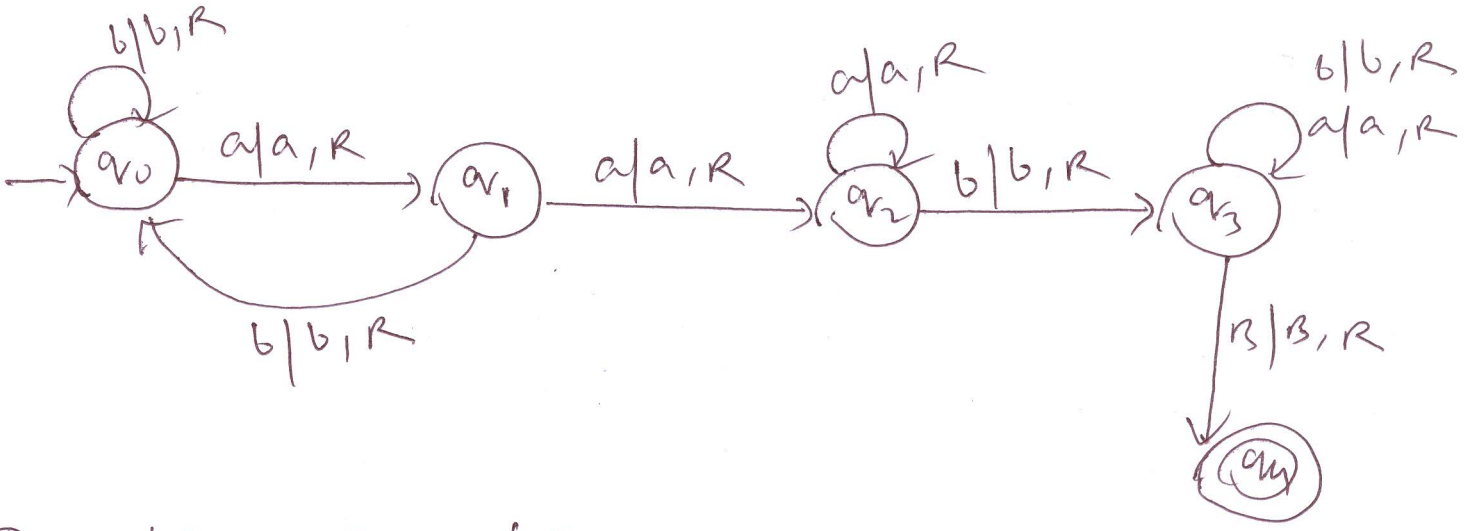
⑨ $\delta(q_3, B) = (q_0, B, R)$

⑩ $\delta(q_2, B) = (q_4, B, L)$

⑪ $\delta(q_4, *) = (q_4, B, L)$

⑫ $\delta(q_4, -) = (q_5, 1, R)$

Q. Design a TM over $\Sigma = \{a, b\}$ which will accept the strings containing "aab" as a substring.



① $\delta(q_0, a) = (q_1, a, R)$

② $\delta(q_0, b) = (q_0, b, R)$

③ $\delta(q_1, b) = (q_1, b, R)$

④ $\delta(q_1, a) = (q_2, a, R)$

⑤ $\delta(q_2, a) = (q_2, a, R)$

⑥ $\delta(q_2, b) = (q_3, b, R)$

⑦ $\delta(q_3, a) = (q_3, a, R)$

⑧ $\delta(q_3, b) = (q_3, b, R)$

⑨ $\delta(q_3, B) = (q_4, B, R)$