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## Tut no :- 8

Q. Design a Turing machine for Language

$L = \{ a^n b^{2n} \mid n \geq 0 \}$

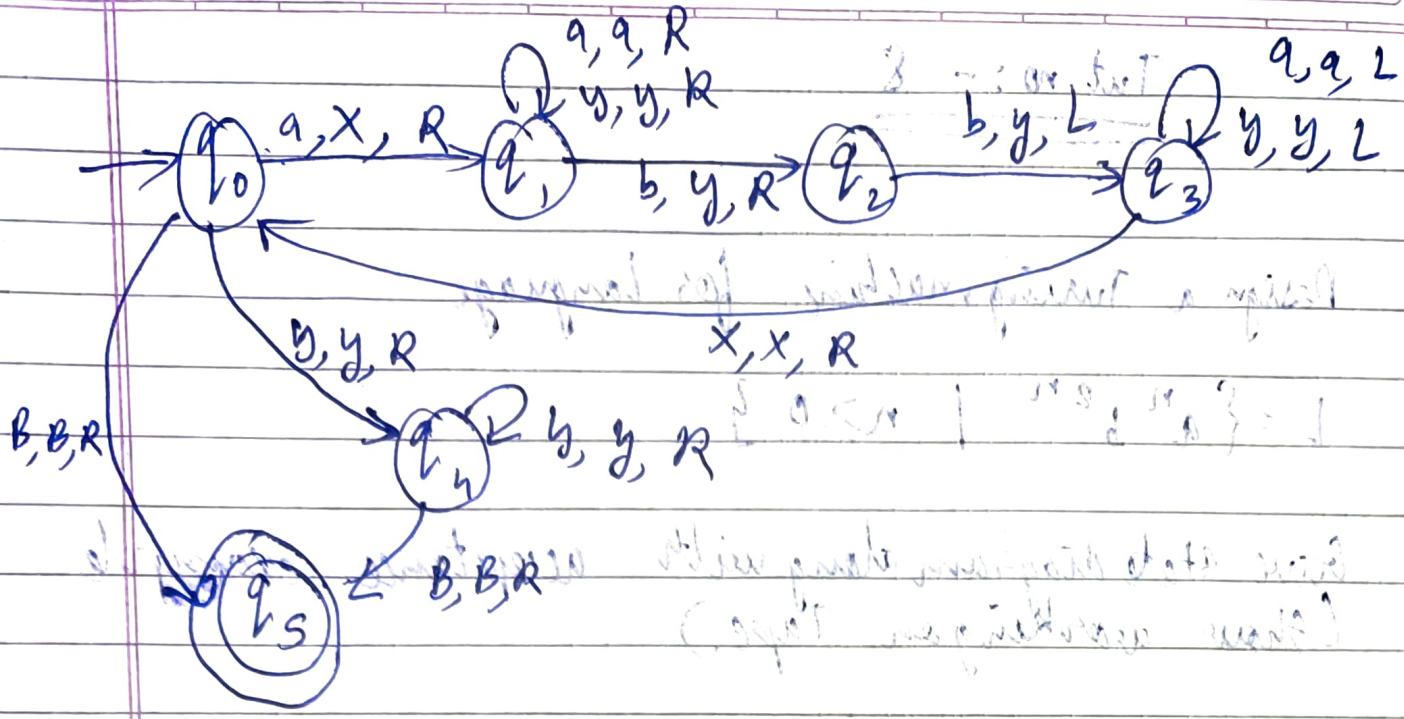
Give state diagram along with acceptance example (Show working on Tape.)

Ans Here $L = \{ \varepsilon, abb, aabbbb, aaabbbbbb \ldots \}$
i.e every a should match 2 b's on the tape.

Logic

- If tape doesn't read anything other than B i.e blank then also string accepted.
- Otherwise tape read will begin with 'a' since it is $a^n b^{2n}$ i.e there is no 'a' after 'b' or no 'b' before 'a'.
- Whenever 'a' is read its replaced by x and search for 'b' where we replace 2 b's with 'y'.
- When all 'a' haven been replaced by 'x' then all 'b' should also have been converted to 'y'.
- Final state should be reached when the tape has all 'x' and 'Y' or only B i.e blank and we have reached end.

R → Right + L → left B → Blank.




$q_0$ → for replacing a with X then move right
$q_1$ → for replacing b with Y then move right
$q_2$ → for replacing b with y then move left
$q_3$ → Comeback
$q_4$ → check if any b is left or Blank (B) is there.

$M = (Q, \Sigma, \Gamma, \delta, q_0, B, F)$
$Q$ = (finite set of states) = $\{q_0, q_1, q_2, q_3, q_4, q_5\}$
$\Sigma$ = (finite set of i/p symbols) = $\{a, b\}$.

$\Gamma$ = (finite set of tape symbols) = $\{B, a, b, X, y\}$.

$\delta$ = (transition function) = $Q \times \Sigma \rightarrow Q \times \Gamma \times (L/R)$

$q_0$ = (initial state) = $q_0$

$B$ = (represents all empty cells) = $B$

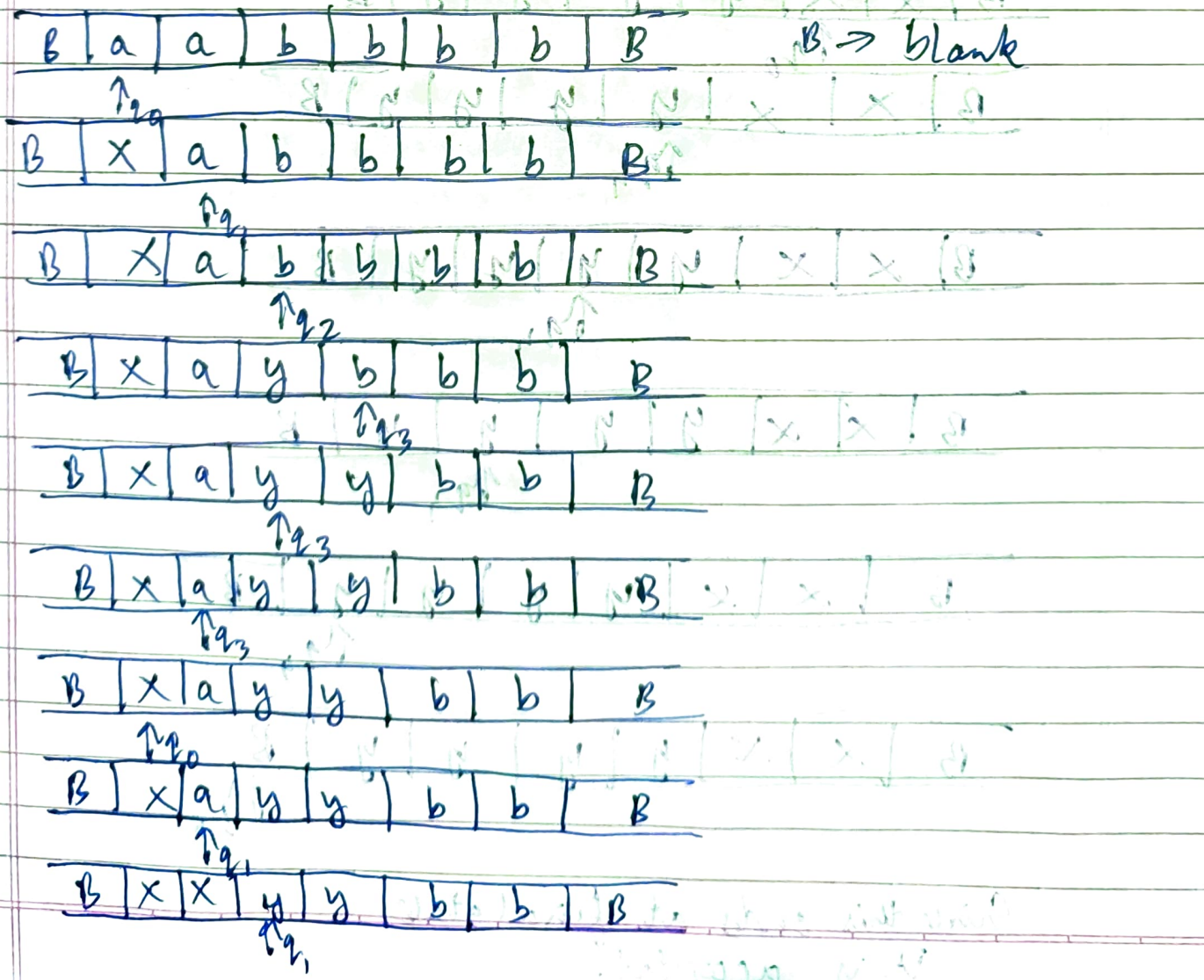
$F$ = (final state) = $\{q_5\}$.

Transition table

| Q / Γ | a | b | X | Y | B |
|---|---|---|---|---|---|
| → $q_0$ | $q_1, X, R$ | H | H | $q_4, y, R$ | $q_5, B, R$ |
| $q_1$ | $q_1, a, R$ | $q_2, y, R$ | H | $q_1, y, R$ | H |
| $q_2$ | H | $q_3, y, L$ | H | H | H |
| $q_3$ | $q_3, a, L$ | H | $q_0, X, R$ | $q_3, y, L$ | H |
| $q_4$ | H | H | H | $q_4, y, R$ | $q_5, B, R$ |
| $q_5$ | $q_5$ | $q_5$ | $q_5$ | $q_5$ | $q_5$ |

Acceptance Example → Testing with a a b b b b

B → blank



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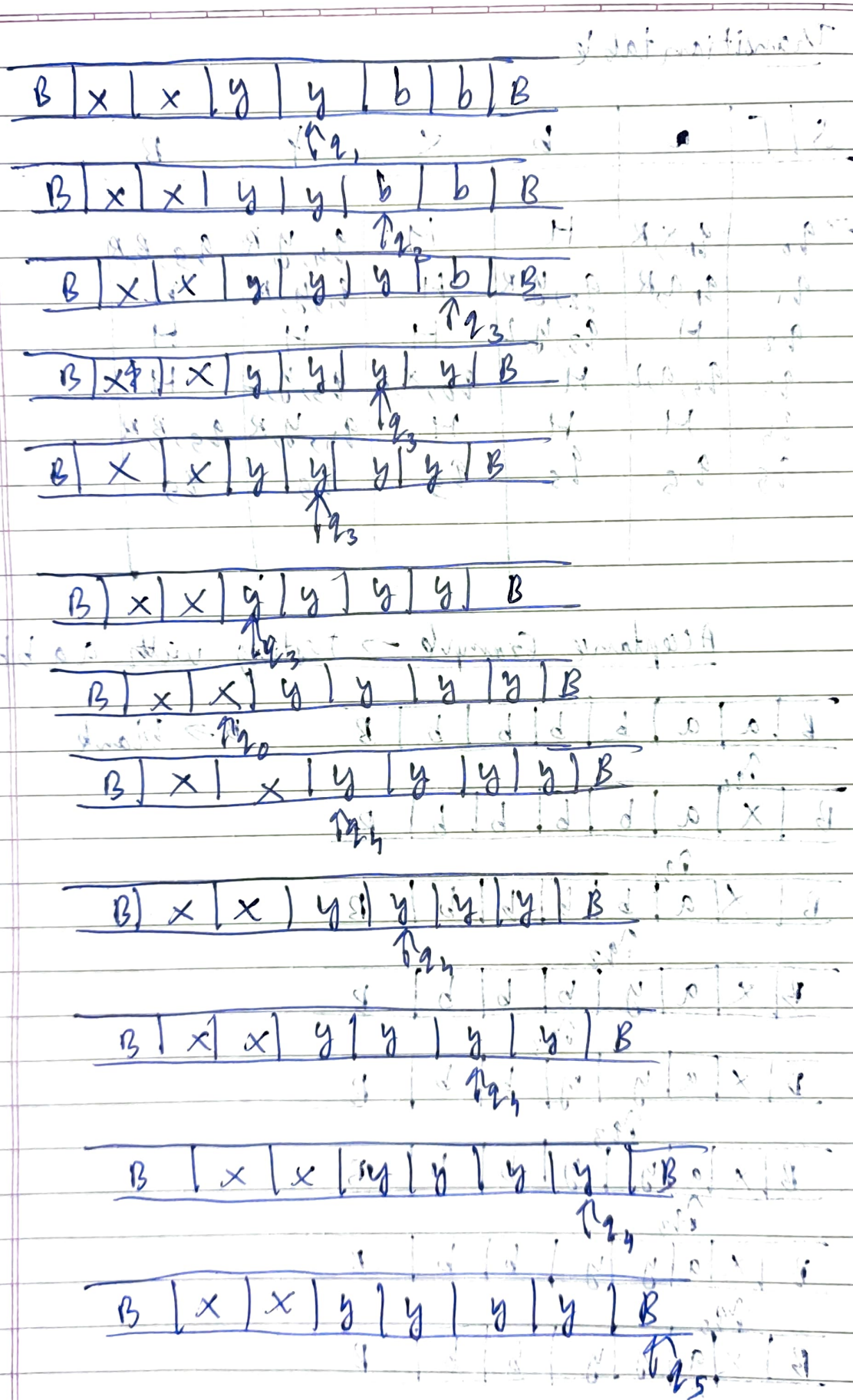


Since this ends at final state
It is accepted.