TM's Problem 9.1 - 8b

TM for $L = \{w : |w| \text{ is odd}, w \in \{a, b\}^+\}$

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algorithm:
  go left most.
  start scanning from left to right.
  first symbol $\Rightarrow q_{odd}$
  subsequent symbols: if $q_{odd} \rightarrow q_{even}$
                      if $q_{even} \rightarrow q_{odd}$
  if q_{odd} @ right #, goto q_{final}

$M = (\{q_0, q_s, q_{odd}, q_{even}, q_f\}, \{a, b\}, \{a, b, \#\}, \delta, q_0, \#, \{q_f\})$

// go leftmost
  (q_0, a, a, L, q_0)
  (q_0, b, b, L, q_0)
  $(q_0, \#, \#, R, q_s)$
// first symbol $\Rightarrow$ odd [always @ least one symbol]

  (q_s, a, a, R, q_{odd})
  (q_s, b, b, R, q_{odd})

// odd $\Rightarrow$ even, even $\Rightarrow$ odd

$(q_{odd}, a, a, R, q_{even})$
$(q_{odd}, b, b, R, q_{even})$
$(q_{even}, a, a, R, q_{odd})$
$(q_{even}, b, b, R, q_{odd})$

// go to final state if odd @ #

$(q_{odd}, \#, \#, L, q_f)$

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instantaneous description:

$w = aba \in L$
$\#ab q_0 a \# \vdash \#a q_0 ba \# \vdash \#q_0 aba \#$
$\vdash \#q_0 \# aba \# \vdash \#\# q_s aba \vdash \#\#a q_{odd} ba\#$
$\vdash \#\#ab q_{even} a \# \vdash \#aba q_{odd} \#$
$\vdash \#ab q_f a \# \checkmark$

$w = abba \notin L$
$\#ab q_0 ba \# \vdash \#a q_0 bba \# \vdash \#q_0 abba \#$
$\vdash \#q_0 \#abba \# \vdash \#\# q_s abba \#$
$\vdash \#\#a q_{odd} bba \vdash \#ab q_{even} ba \#$
$\vdash \#abb q_{odd} a \# \vdash \#abba q_{even} \#$

[dead configuration
$\therefore$ halt in non-
final state
$\Rightarrow$ not accepted]