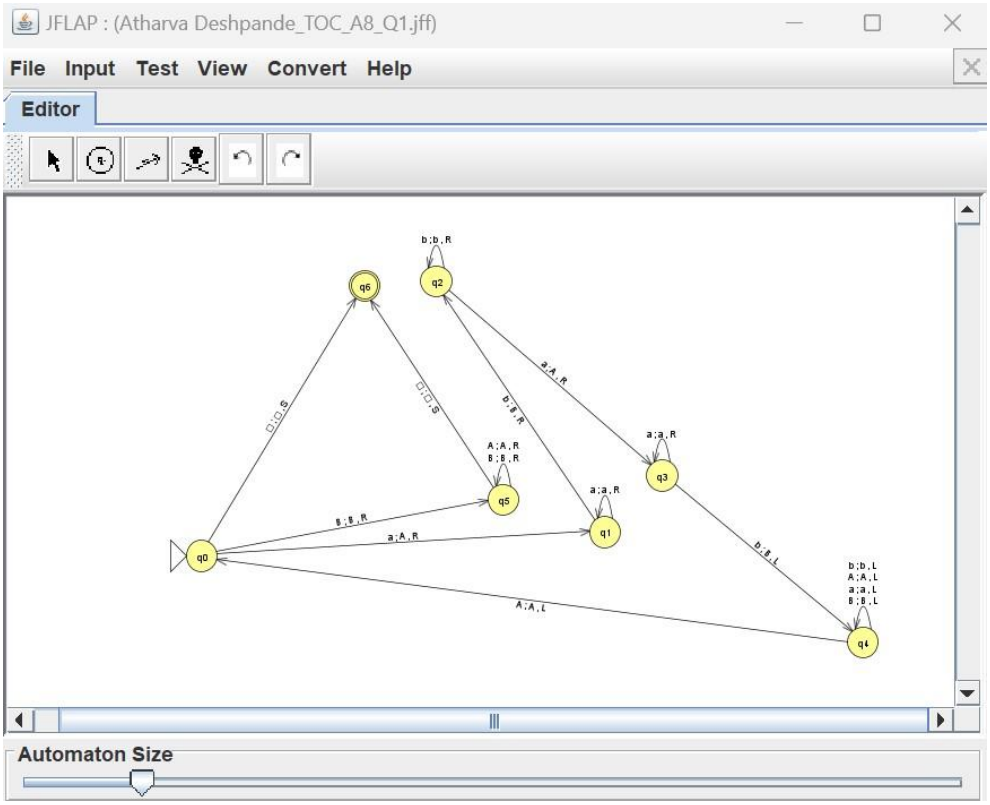
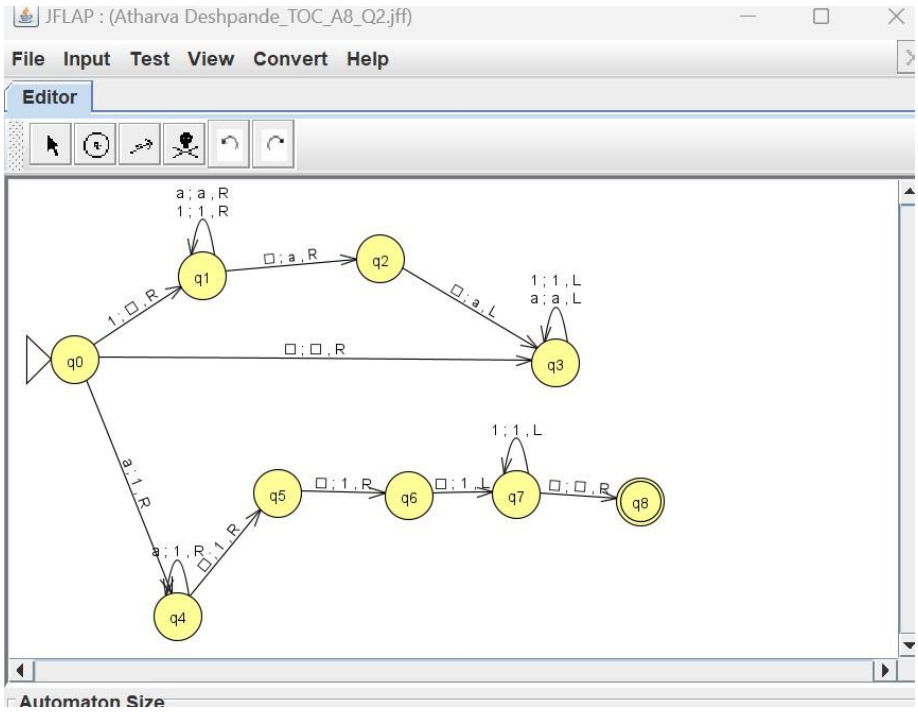
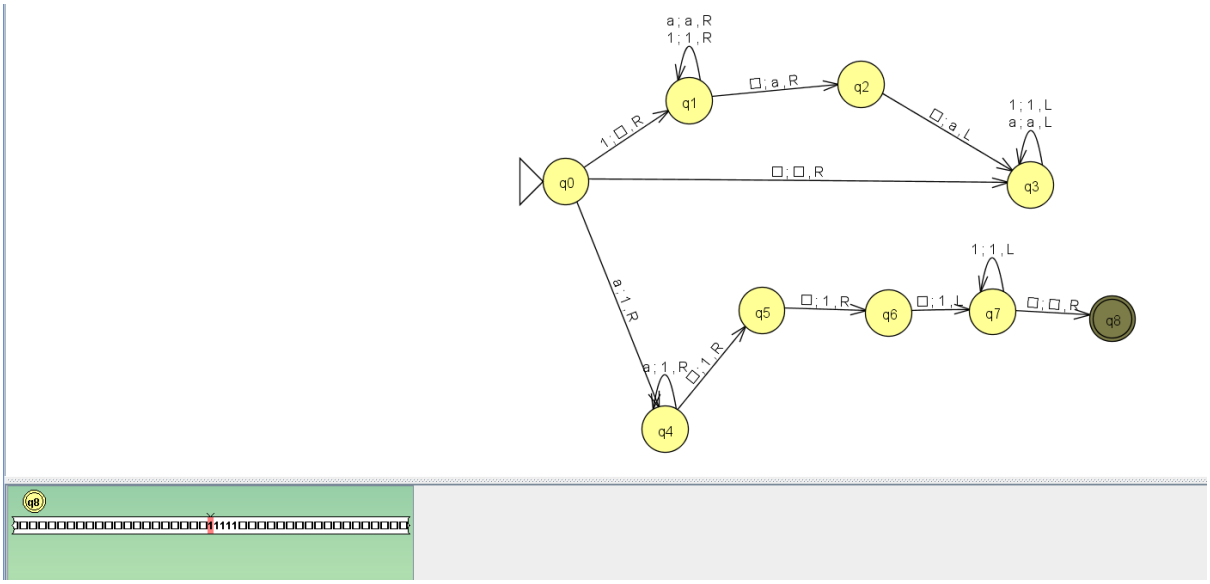
1. Create a Turing machine that accepts the language $\{a^n b^n a^n b^n : n > 0\}$.



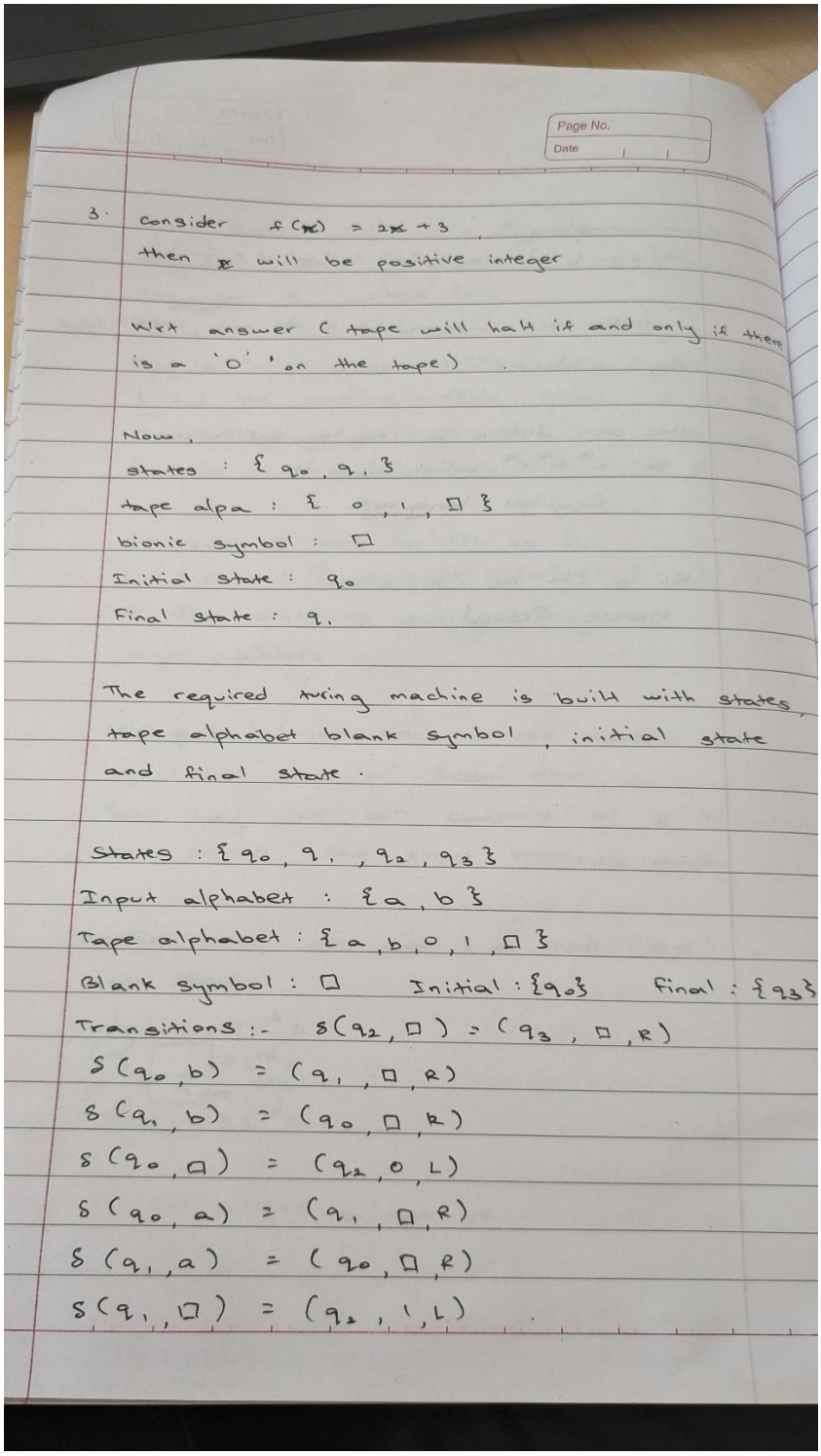
2. Create a Turing machine that computes the function f(x) = 2x + 3, where x is a positive integer represented in unary.



aa as input:



3. For this problem, the tape can start with 0s and 1s scattered anywhere on the tape - they do not have to be contiguous. Any permutation of 0s, 1s and blanks is a possible starting configuration. Create a Turing machine that when started anywhere on the tape will halt if and only if there is a 0 somewhere on the tape.



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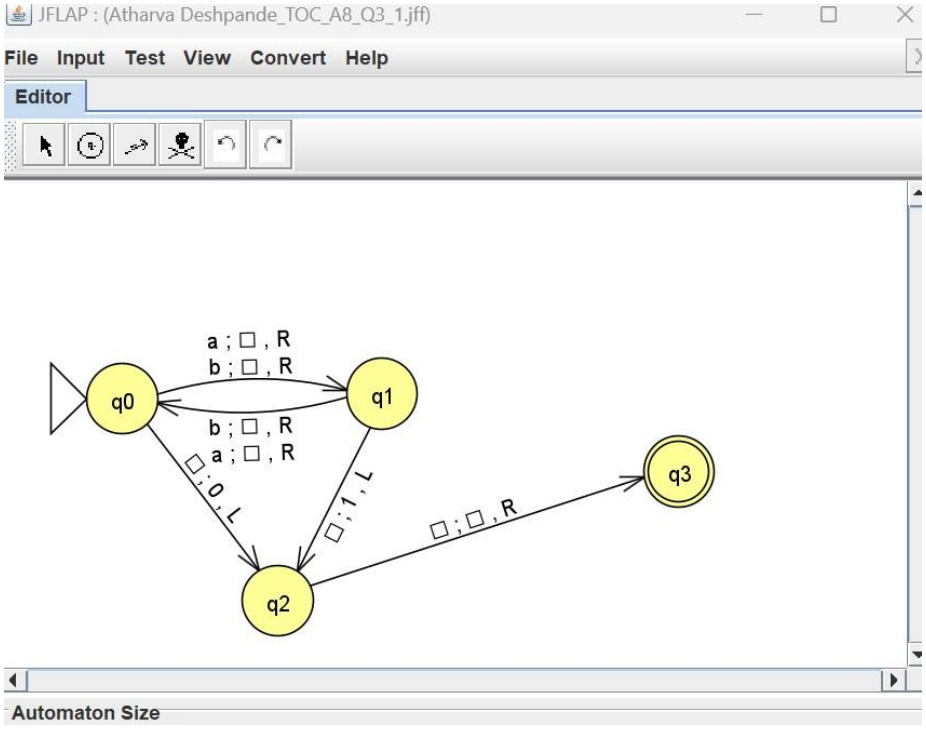
3. Consider $f(x) = 2x + 3$
then x will be positive integer

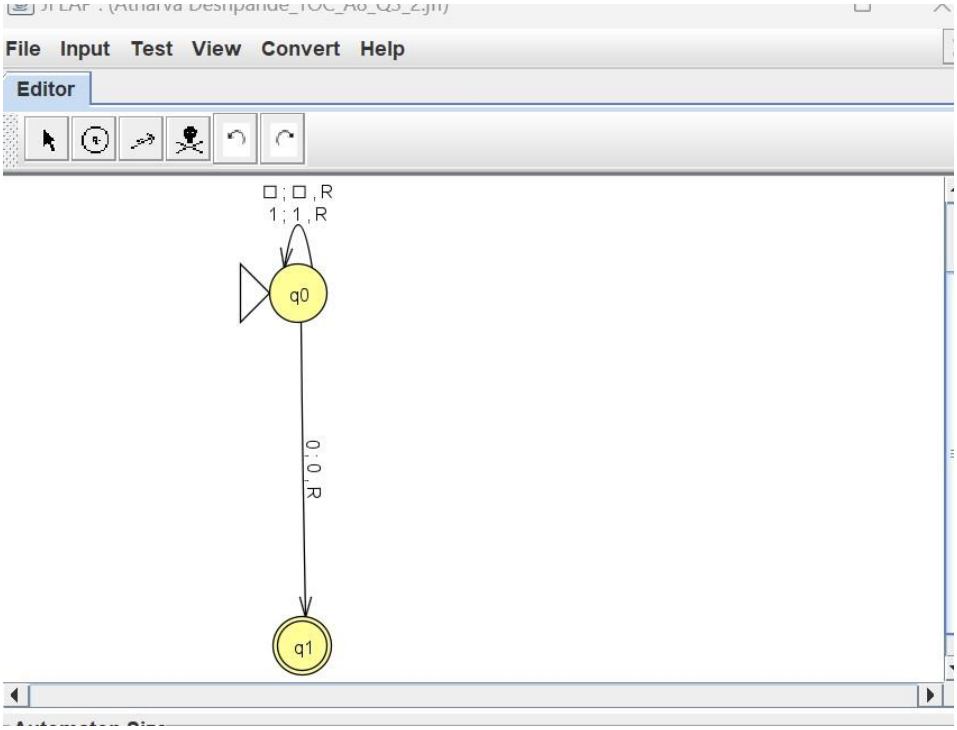
Wrt answer (tape will halt if and only if there is a '0' on the tape)

Now,
states : $\{q_0, q_1\}$
tape alpa : $\{0, 1, \square\}$
bionic symbol : $\square$
Initial state : q_0
Final state : q_1

The required turing machine is built with states, tape alphabet blank symbol, initial state and final state.

States : $\{q_0, q_1, q_2, q_3\}$
Input alphabet : $\{a, b\}$
Tape alphabet : $\{a, b, 0, 1, \square\}$
Blank symbol : $\square$ Initial : $\{q_0\}$ final : $\{q_3\}$
Transitions :- $\delta(q_2, \square) = (q_3, \square, R)$
$\delta(q_0, b) = (q_1, \square, R)$
$\delta(q_1, b) = (q_0, \square, R)$
$\delta(q_0, \square) = (q_2, 0, L)$
$\delta(q_0, a) = (q_1, \square, R)$
$\delta(q_1, a) = (q_0, \square, R)$
$\delta(q_1, \square) = (q_2, 1, L)$





qo will be moving to the right unless the proceeding angle makes 0 to the tape.

The head keeps moving to the right until a 0 if found on the head of the tape.