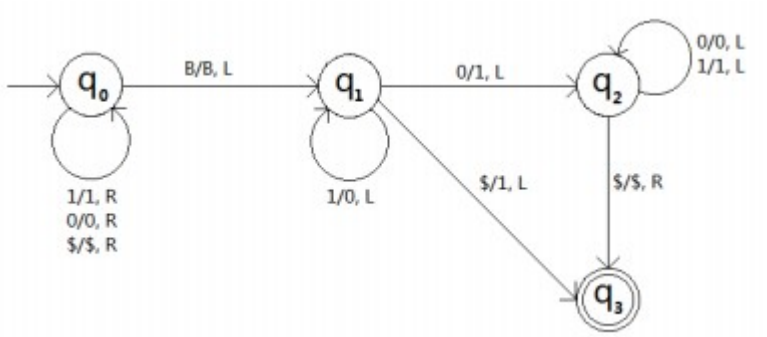
Assignment 6 - CS 301 - Theory of Automata – Fall 2020

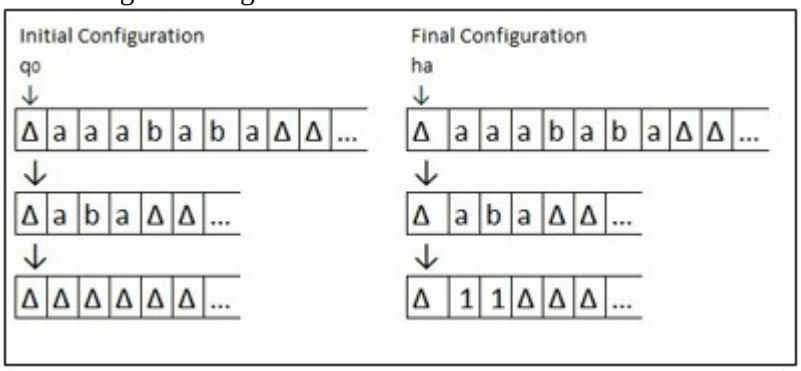
Due: December 13, 2020 (11.59 PM). Late submission until December 15 (8 AM) is allowed with 30% penalty.

1. [10] Design a single tape deterministic Turing machine that takes as input a number N and adds 1 to it in binary. To be precise, the tape initially contains a $ followed by N in binary. The tape head is initially scanning the $ in state q0. Your TM should halt with N + 1, in binary, on its tape, scanning the leftmost symbol of N + 1, in state qf.



2. [20] (from previous exam)
   Given 2 Strings X and Y such that X,Y ϵ $\{a,b\}^+$ Construct a Turing Machine that outputs the number of times Y appears in X.
   Your Turing machine will have 3 tapes. Tape 1 will have X as input, Tape 2 will have Y as input, and on Tape 3 you have to write the output. As your output is the number of times Y appears in X, it should be in unary form.

   Following is an example of initial and final configuration of such Turing machine if X= **aaababab** and Y=**abab.**is given in figure below



NOTE: Output is 11 are there are two occurrences of Y in X (aaababab)

You also have to write a brief algorithm of your machine

Algorithm:

0).If X has not ended
1)……Look for character on X that matches first character of Y, left to right starting from current head of ……tape
2)……If found, mark that character in X as xdot
3)……..Now Keep matching X and Y from left to right

4)……..If Y matches with X completely

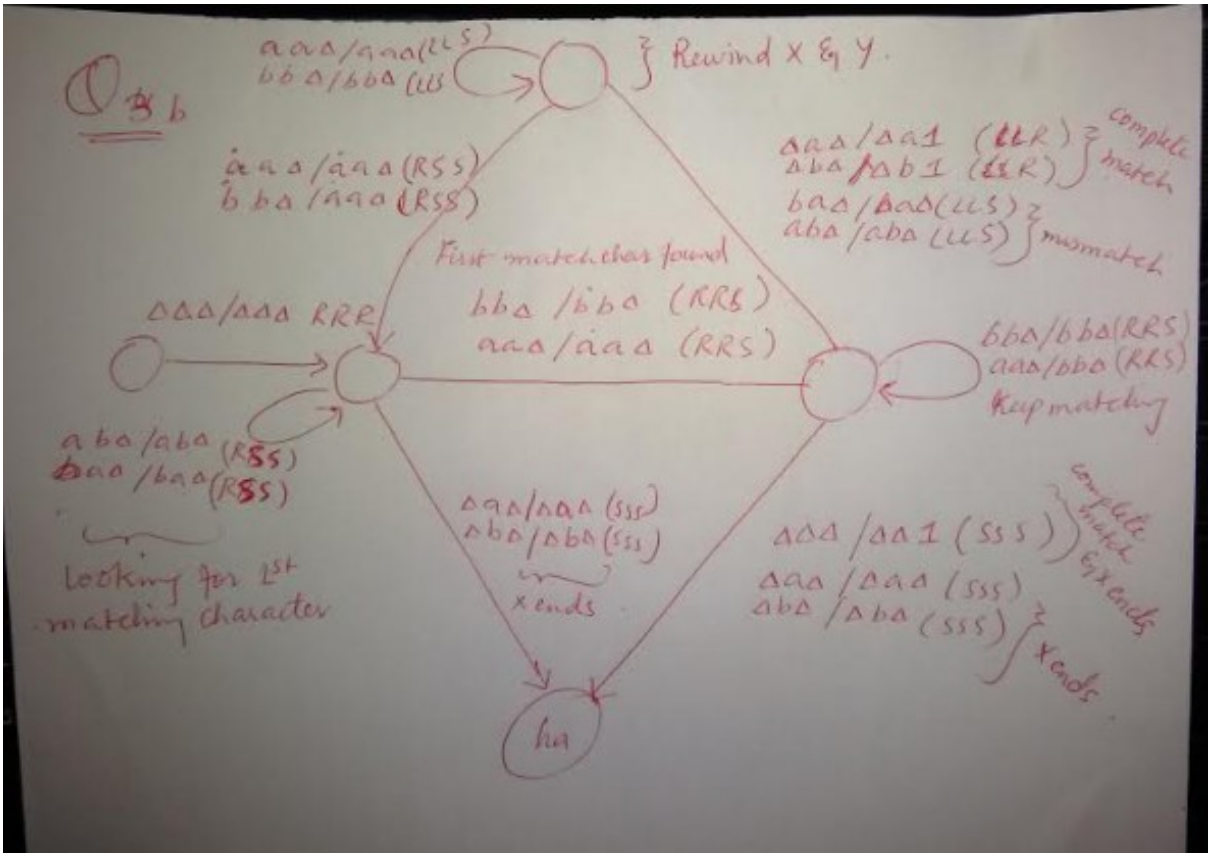
5)……..Place 1 in tape 3

6)……..Rewind tape1 and tape2 heads by moving tape 1 to one right from last xdot and ……..tape 2 to first symbol of Y

……..Goto 0

7). Else goto accept state

NOTE: Rewinding tape 1 is necessary to find overlapping Y's in X. It is also necessary in case where Y and X partially match before complete match, for example if X=aaab and Y=aab. Most of the students made mistake in this part, so if you see this comment in you paper "Rewind X aswell, the explanation precedes.



3. [10] (from previous exam)
   Consider the Turing machine T: Its alphabet set ∑ = {1}. The tape alphabet i.e. the letters that can be written on the tape consists of {1, 0, #, D, E, N, O, V }. The tape initially contains a series of 1's. This can be considered as input data.

Construct a single tape deterministic Turing machine that determines whether the number of 1's in the series are odd or even. If the number of 1's is odd write ODD at the end of the tape otherwise write EVEN. The word ODD or EVEN must be written precisely after the input.
The constraint: Your Turning machine must be efficient in terms of time. That is, it should be able to give the answer in minimum number of steps.
Example:
Input: 1111
Output: XXXXEVEN X indicates these values can be anything after the Turing machine halts.