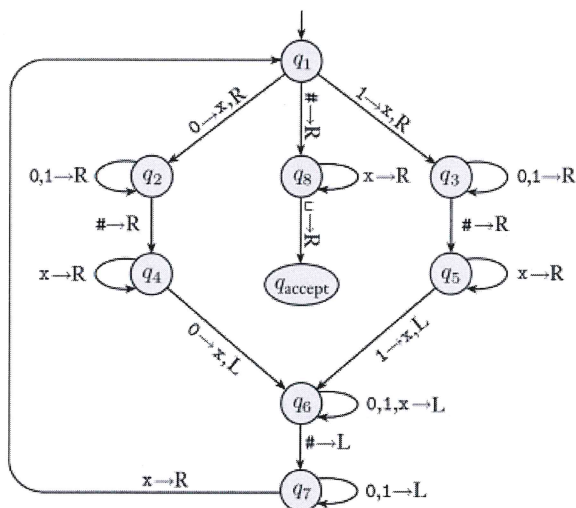1. (__ /3 pts) Consider the TM M_1 given below. Give the sequence of configurations that M_1 enters when started on the input string 10#1.

q_1 10 # 1

$x\ q_3$ 0 # 1

$x\ O\ q_3$ # 1

$x\ O$ # q_5 1

$x\ O\ q_6$ # x

$x\ q_7$ 0 # x

q_7 x O # x

$x\ q_1$ 0 # x

$x\ x\ q_2$ # x

$x\ x$ # q_4 x

$x\ x$ # $x\ q_4$

computation
dies.

2. (__ /3 pts) For each of the following statements, circle **TRUE** or **FALSE**.

- **TRUE**/~~**FALSE**~~ - Every TM must have at least 3 distinct states, implicit or otherwise: q_{start}, q_{accept}, and q_{reject}. It is possible that $q_{start} = q_{accept}$.
- ~~**TRUE**~~/**FALSE** - A TM's transition function has domain $Q \times \Gamma$.
- **TRUE**/~~**FALSE**~~ - Turing-recognizable languages are closed under union, but decidable languages are not. Both are closed under union.

3. (__ /4 pts) Describe a TM which decides the language

$$A = \{\#x_1\#x_2\#\ldots\#x_k \mid x_i \in \{0,1\}^* \text{ and } x_i = x_j \text{ for some } i \neq j\}.$$

1. Place mark on leftmost symbol. If it was ⊔, reject. If #, continue. Otherwise, reject.

2. Scan right to the next # and place a mark on top of it. If no # encountered before ⊔, only x_i is present, so reject.

3. By Zig-Zagging, compare the two strings to the right of the marked #s. If they are equal, accept. ∎

4. Move rightmost mark to next #. If no # is encountered, move leftmost mark to next hash and rightmost to the # after that. If not possible, all pairs of strings have been checked, so reject.

5. Go to step 3.