

3.1 (a) 0.

$q_1 0 \sqcup$   
 $\sqcup q_2 \sqcup$   
 $\sqcup \sqcup q_{accept}$

(b) 00.

$q_1 0 0 \sqcup$   
 $\sqcup q_2 0 \sqcup$   
 $\sqcup x q_3 \sqcup$   
 $\sqcup q_5 x \sqcup$   
 $q_5 \sqcup x \sqcup$   
 $\sqcup q_2 x \sqcup$   
 $\sqcup x q_2 \sqcup$   
 $\sqcup x \sqcup q_{accept}$

(c) 000.

$q_1 0 0 0 \sqcup$   
 $\sqcup q_2 0 0 \sqcup$   
 $\sqcup x q_3 0 \sqcup$   
 $\sqcup x 0 q_4 \sqcup$   
 $\sqcup x 0 \sqcup q_{reject}$

(d) 000000.

$q_1 000000 \sqcup$   
 $\sqcup q_2 000000 \sqcup$   
 $\sqcup x 0 q_4 000 \sqcup$   
 $\sqcup x 0 x q_3 00 \sqcup$   
 $\sqcup x 0 x 0 q_4 0 \sqcup$   
 $\sqcup x 0 x 0 x q_3 \sqcup$   
 $\sqcup x 0 x 0 q_5 x \sqcup$   
 $\sqcup x 0 x q_5 0 x \sqcup$   
 $\sqcup x 0 q_5 x 0 x \sqcup$   
 $\sqcup x q_5 0 x 0 x \sqcup$   
 $\sqcup q_5 x 0 x 0 x \sqcup$   
 $q_2 \sqcup x 0 x 0 x \sqcup$   
 $\sqcup q_2 x 0 x 0 x \sqcup$   
 $\sqcup x q_2 0 x 0 x \sqcup$   
 $\sqcup x x q_3 x 0 x \sqcup$   
 $\sqcup x x x 0 q_4 x \sqcup$   
 $\sqcup x x x 0 x q_4 \sqcup$   
 $\sqcup x x x 0 x \sqcup q_{reject}$

3.2 (a) 11.

$q_1 11 \sqcup$   
 $x q_3 1 \sqcup$   
 $x 1 q_3 \sqcup$   
 $x 1 q_{reject} \sqcup$

(b)  $1\#1$ .

$q_1 1 \# 1 \sqcup$   
 $x q_3 \# 1 \sqcup$   
 $x \# q_5 1 \sqcup$   
 $x q_6 \# x \sqcup$   
 $q_7 x \# x \sqcup$   
 $x q_1 \# x \sqcup$   
 $x \# q_8 x \sqcup$   
 $x \# x q_8 \sqcup$   
 $x \# x \sqcup q_{accept}$

(c)  $1\#\#1$ .

$q_1 1 \# \# 1 \sqcup$   
 $x \# q_5 \# 1 \sqcup$   
 $x \# q_{reject} \# 1 \sqcup$

(d)  $10\#11$ .

$q_1 1 0 \# 1 1 \sqcup$   
 $x q_3 0 \# 1 1 \sqcup$   
 $x 0 q_3 \# 1 1 \sqcup$   
 $x 0 \# q_5 1 1 \sqcup$   
 $x 0 q_5 \# x 1 \sqcup$   
 $x 0 q_6 \# x 1 \sqcup$   
 $x q_7 0 \# x 1 \sqcup$   
 $q_7 x 0 \# x 1 \sqcup$   
 $x q_1 0 \# x 1 \sqcup$   
 $x x q_2 \# x 1 \sqcup$   
 $x x \# q_4 x 1 \sqcup$   
 $x x \# x q_4 1 \sqcup$   
 $x x \# x q_{reject} 1 \sqcup$

(e)  $10\#10$ .

$q_1 1 0 \# 1 0 \sqcup$   
 $x q_3 0 \# 1 0 \sqcup$   
 $x 0 q_3 \# 1 0 \sqcup$   
 $x 0 \# q_5 1 0 \sqcup$   
 $x 0 q_6 \# x 0 \sqcup$   
 $x q_7 0 \# x 0 \sqcup$   
 $q_7 x 0 \# x 0 \sqcup$   
 $x q_1 0 \# x 0 \sqcup$   
 $x x q_2 \# x 0 \sqcup$   
 $x x \# q_4 x 0 \sqcup$   
 $x x \# x q_4 0 \sqcup$   
 $x x \# q_6 x x \sqcup$   
 $x x q_6 \# x x \sqcup$   
 $x q_7 x \# x x \sqcup$   
 $x x q_1 \# x x \sqcup$   
 $x x \# q_8 x x \sqcup$   
 $x x \# x q_8 x \sqcup$   
 $x x \# x x q_8 \sqcup$   
 $x x \# x x \sqcup q_{accept}$

3.3 Solution in book.

3.4 An enumerator  $E$  can be defined as a 2-tape Turing machine with the transition function:

$$\delta : Q \times \Gamma_{tape} \longrightarrow Q \times \Gamma_{tape} \times \Gamma_{print} \times \{L, R, S\} \times \{R, S\}$$

The language enumerated by the enumerator is  $L \subseteq \Gamma_p^*$ .

3.5 Solution in book.

3.6 For any given  $S_i$ , there is no guarantee  $M$  will not loop (i.e. not accept or reject the input), meaning there is no guarantee the algorithm will complete.