Q1. $\{ b_i \# b_{i+1}^R : b_i$ is the binary representation of some integer i, $i \geq 0$, without leading zeros$\}$.

(For example $101 \# 011 \in L$.)

$(s, 1, e) \quad (s, 1)$

$(s, 0, e) \quad (s, 0)$

$(s, \#, e) \quad (f_1, e)$

$(f_1, 1, 0) \quad (f, e)$

$(f_1, 0, 1) \quad (f_2, e)$

$(f_2, 0, 1) \quad (f_2, e)$

$(f_2, 1, 0) \quad (f, e)$

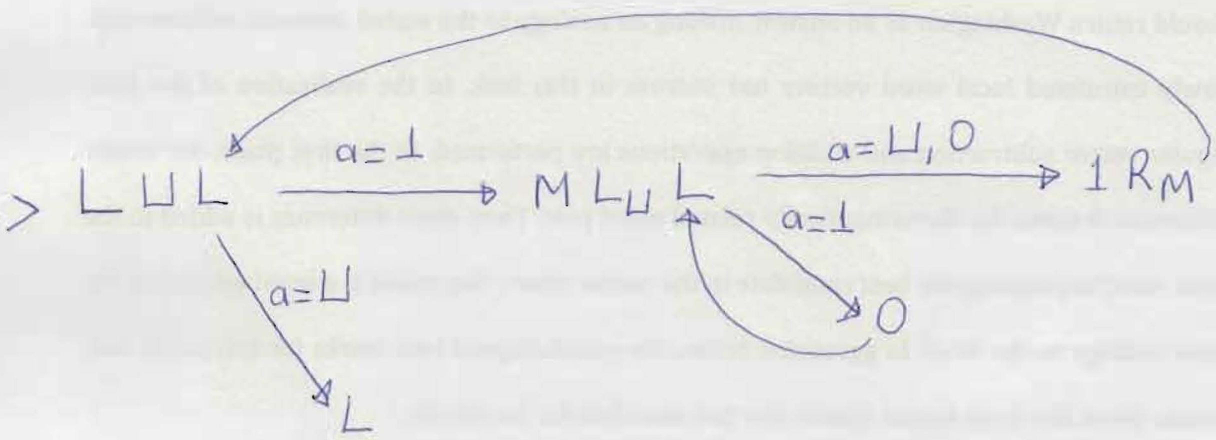
$(f_2, 1, e) \quad (f, e)$

$(f, 0, 0) \quad (f, e)$

$(f, 1, 1) \quad (f, e)$

Q2.

$\underbrace{\sqcup 1111 \underline{\sqcup}}_{\text{3 in unary}}$ $\qquad$ $\underbrace{\sqcup 11 \sqcup}_{\text{3 in binary}}$



$\sqcup 1111 \underline{\sqcup}$

$\sqcup 111\underline{1} \sqcup \sqcup$

$\underline{1} \sqcup 1\underline{1} M \sqcup \sqcup$

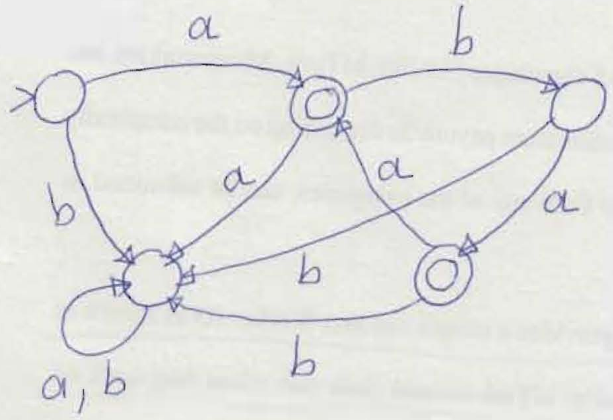
$\underline{1} 0 \sqcup \underline{1} M M \sqcup \sqcup$

$\underline{1} 1 \underline{\sqcup} M M M \sqcup \sqcup$

$1 \underline{1} \sqcup M M M \sqcup \sqcup$

Q3.

1. $L = (ab \cup aba)^* a$



[e] : concatenate with a to make it member

[a] : member

[aba] : member but different from [a].

[ab] : concatenate with a to make it member.

[b] : no possibility to become a member.

2. The language of balanced parentheses.

[e] : already member

[(] : concatenate with) to make it member.

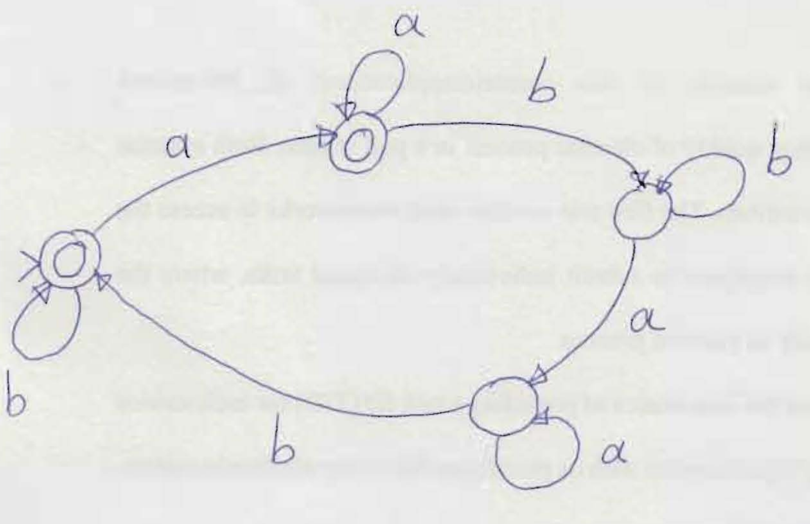
[((] : Concatenate with)) to make it member.

[((( )( )] : concatenate with))) to make it member.

⋮

There are infinitely many equivalence classes.

Q4. Build a DFA that accepts only those words that have an even number of substrings ab.



$$[b \cup aa^{*}bb^{*}aa^{*}b]^{*} \cup b^{*}a[a \cup bb^{*}aa^{*}bb^{*}a]^{*}$$

Q5. Give a context-free grammar generating the complement of the following language:

$\{a^n b^n \mid n \geq 0\}$

$S \rightarrow aA \mid bB$

$B \rightarrow aB \mid bB \mid e$

$A \rightarrow aAa \mid aAb \mid bAa \mid bAb \mid e \mid a \mid bb$