Regular Languages: Questions

1. What language is represented by the regular expression (((a* a)b) | b)?
2. Rewrite each of the following regular expressions as simpler expressions describing the same language:
    a. ε* | a* | b* | (a|b)*
    b. ((a* b*)* (b*a*)*)*
    c. (a*b)* | (b*a)*
    d. (a|b)* a (a|b)*

3. Let Σ={a,b}. Write regular expressions to describe the following languages:
    a. All strings in Σ* with no more than three a's.
    b. All strings in Σ* with a number of a's divisible by three.
    c. All strings in Σ* with exactly one occurrence of the substring aaa.

4. Indicate whether each of the following is true or false:
    a. baa ∈ L(a*b*a*b*)
    b. $L(b^*a^*) \cap L(a^*b^*) = L(a^*) \cup L(b^*)$
    c. $L(a^*b^*) \cap L(b^*c^*) = \varnothing$
    d. abcd ∈ L(a(cd)*b)*

5. Construct deterministic finite automata to recognise each of the languages specified in question 2.
6. Construct deterministic finite automata to recognise each of the languages specified in question 3.
7.
    a. Consider the following non-deterministic finite automaton:

State	Symbol	δ(State,Symbol)
0	a	0
0	a	1
1	b	1

    where the start state is 0, and the accepting state is 0.

    Indicate whether or not each of the following strings is accepted by this NFA:

        i. a
        ii. aa
        iii. aab
        iv. ε

b. Consider the following non-deterministic finite automaton:

State	Symbol	δ(State,Symbol)
0	a	1
1	b	2
1	b	3
2	a	3
3	a	1

where the start state is 0, and the accepting states are 0 and 3.

Indicate whether or not each of the following strings is accepted by this NFA:

i. ε
ii. ab
iii. abab
iv. aba
v. abaa

8. Convert the NFAs in question 7 into equivalent DFAs which recognise the same language.
9. Consider the following regular grammar:

S -> aS
S -> bS
S -> aA
S -> a
A -> aA
A -> bA
A -> a
A -> b

Construct a finite state automaton which can be used to recognise the same language.

10. Use the pumping lemma to show that the following languages are not regular:
    a. $\{ww^r \mid w \in \{a,b\}^*\}$
    b. $\{ww \mid w \in \{a,b\}^*\}$