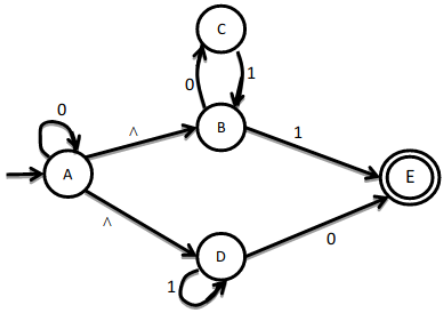
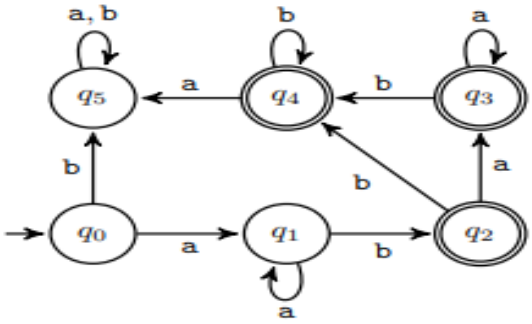
Birla Institute of Technology and Science, Pilani
CS F351, Theory of Computation
Practice Questions on Regular Languages

1) Make a DFSM to accept language defined by each of the following regular expression:
   i) (aba U aabaa)* ii) (ab)*(aab)*
2) Construct NFA accepting all string (a's & b's). Reading from RHS 3rd input symbol should be 'a'. Convert the above NFA into DFA.
3) Find the regular expression that generate a string of alphabet {a,b}, where each string have even number of 0's followed by an odd number of 1's.
4) L = $\{wxw^R \mid w,x \in \{0,1\}^+\}$. Is L a regular language? **[Note: It is a regular language. Prove it.]**
5) Make a DFA which accepts string from {a,b}* satisfying below conditions
   i) Each string has exactly 2 a's and length of the string is divisible by 3.
6) Find the number of state in minimal DFA that accept all the string of {0,1}*, where every string start with "10" and the length of string is congruent (0 mod 3).
7) Write a regular expression where no two a's and no two b's come together.
8) Make regular expression for L = $\{0^m1^n \mid m+n=odd\}$.
9) Consider two regular expression P and Q where P={(01)*+1}* and Q={(01)*(1(01)*)*}. Find the relation between them:
   a) P==Q
   b) P is a subset of Q.
   c) Q is a subset of P.
   d) none.
10) r = (bb * a) * bb * (a + b) b * make DFA for the given expression.
11) Make i) DFA $F_1 = \{w \in \{0,1\}\}^* | \#_0(w)$ is divisible by 3 and $\#_1(w)$ is divisible by 5}
   ii) DFA $F_2 = \{w \in \{0,1\}\}^* | \#_0(w)$ is even and $\#_1(w)$ is odd}

   Make $F_3 = F_1 \cap F_2$.
12) Convert given NFA-^ to DFA :



13) Which language does the DFA accept? ii) Specify a regular grammar, which generates the same language.



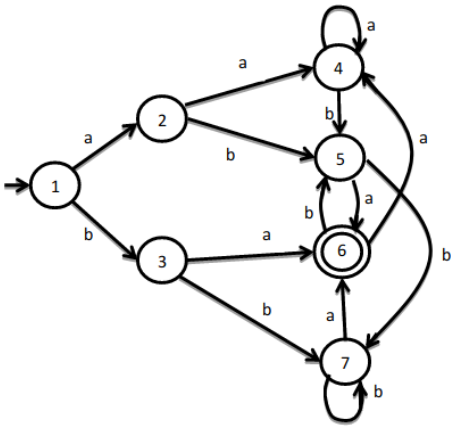
14) Write a Regular Expression for a string made up of {0,1}* :

i) String must end with 101 and ii) Shouldn't have 010 as subsrting.

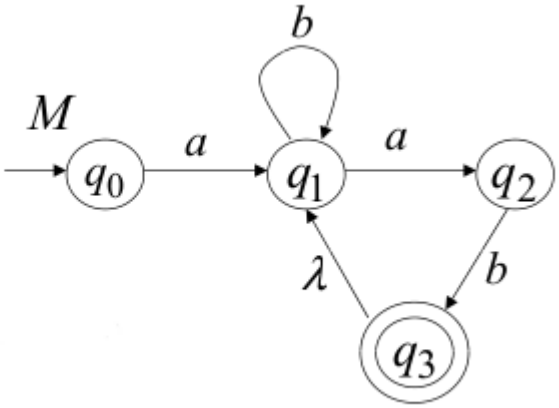
15) Draw the NFA for that recognizes the set of strings on the alphabet {0, 1} that start and end with a 1, and in which every 0 is immediately preceded by at least two 1's.

16) Draw the NFA for following language on the alphabet {0} L = { $\{0^k$: k mod 2 = 0 or k mod = 3} }

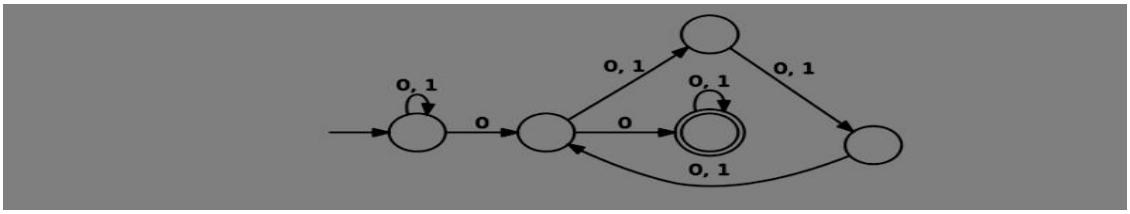
17) For the following FA find the minimized FA accepting the same language:



18) Convert NFA to a right-linear grammar:



Q19) Consider the following non-deterministic finite automaton (NFA) over the alphabet Σ = {0, 1}. Give a one-sentence description of the language recognized by the NFA. Write a regular expression for this language.



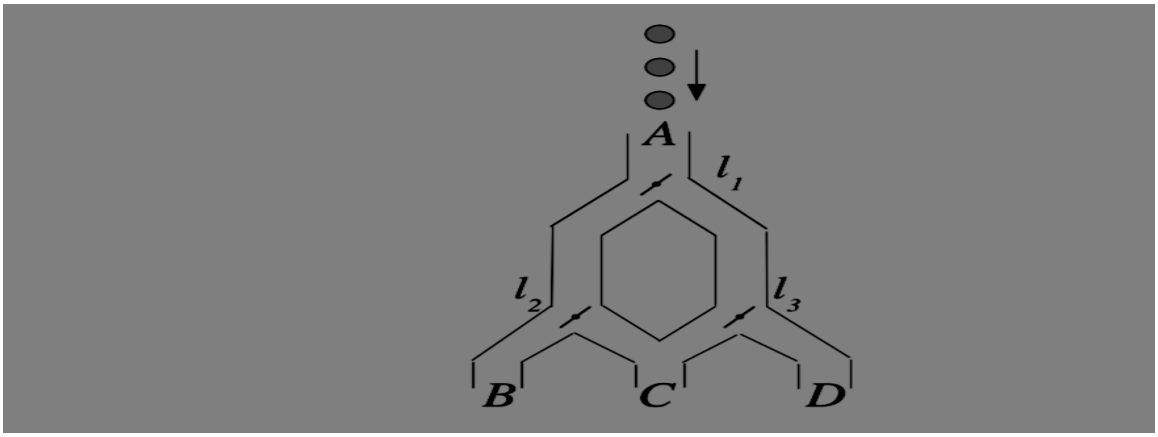
Q20) Given that A is regular and A∪B is regular, does it follow that B is necessarily regular? Justify your answer.
Q21) Given two finite automata M1, M2, outline an algorithm to decide if L(M1)⊆L(M2).

Q22) What is the language generated by this regular expression ?
(b + ε) (a + ab)*

Q23) a) Suppose there is a robot which should wander randomly through the library, and if it finds a book not on the shelves, it should take it to the book return bin. If it gets low on energy, it should go to an open outlet and plug in for 30 minutes. Give the formal definition, as well as the state transition diagram, of a reasonable DFA to control this behavior.

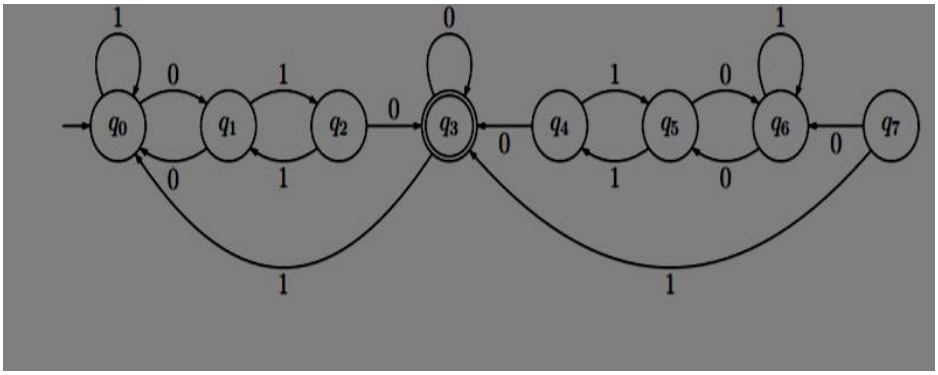
Q24)
Give the formal definition (i.e., clear, detailed descriptions of all the sets and functions in the DFA) and state diagram of a DFA to control the elevator for a building with 4 floors. This must handle button pushes requesting up or down from any floor at any time. Discuss the options you choose for the DFA, what role time plays, and defend your choice of input alphabet, transition function, start and final states.

Q25)
Consider a toy, as shown on the diagram below. A marble is dropped into the pipe A. The levers l1, l2, and l3 cause a marble to fall either left or right. Whenever a marble encounters a lever, it causes the lever to change state, so that the next marble that encounter the lever will fall to the opposite direction. The initial positions of the levers are as depicted in the diagram.
Your task is to model this toy by a DFA. Denote a marble at pipe A by a 0-input, so your input alphabet Σ is {0}. A sequence of inputs is accepted if the last marble comes out of pipe C. For example: a sequence 0 should be rejected, a sequence 000 should be accepted.
(a) Draw the state transition diagram for DFA, and explain the meaning of the states in DFA
(b) Describe the language accepted by your DFA.
(c) Write a regular expression for the language accepted by your DFA



Q26)

Learn and understand the algorithm for minimization of DFAs .Find the minimum-state DFA equivalent to the DFA described by the following transition diagram:



Q27)

Let M = (Q, Σ, δ, q0, F) be a DFA where Q contains k states. Show that if L(M) ≠ ∅ then L(M) must contain at least one string of length at most k − 1.

Q28)

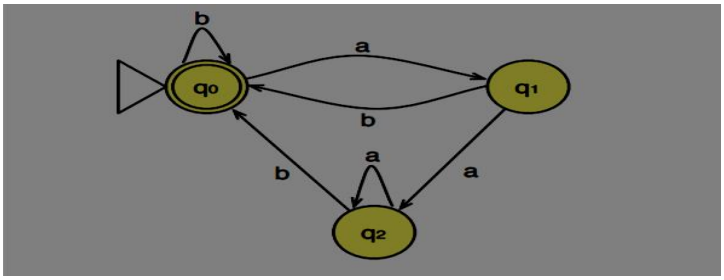
In some applications, such as programs that check spelling, we may not need an exact match of the pattern, only an approximate one. Once the notion of an approximate match has been made precise, automata theory can be applied to construct approximate pattern matchers. As an illustration of this, consider patterns derived from the original ones by insertion of one symbol.
Let L be a regular language on Σ and define
insert (L) = {uav : a ∈ Σ,uv ∈ L}.
In effect, insert (L) contains all the words created from L by inserting a spurious symbol anywhere in a word.

(a) Given an nfa for L, show how one can construct an nfa for insert (L).

(b) Discuss how you might use this to write a pattern-recognition program for insert (L), using as input a regular expression for L.

Q29)

Convert the following DFA into a regular expression using state elimination.



Q30) Definition of a language L with alphabet { a } is given as following.

L ={ a^{nk} | k > 0, and n is a positive integer constant }

What is the minimum number of states needed in a DFA to recognize L ?