PES UNIVERSITY, Bangalore

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Department of Computer Science & Engineering

Automata Formal Languages & Logic

Question Bank - Unit 2

Questions from the Prescribed Textbook

Topic	Exercise No.	Question No's
Pumping lemma	4.3	Q1-Q27

Extra Questions

1. Prove that the following languages are not regular.You may use the pumping lemma and the closure of the class of regular languages under union, intersection and complement.
    a) $\{0^n1^m0^n \mid m,n >=0\}$
    b) $\{wtw \mid w,t \in \{0,1\}^*\}$
2. Let $\sum$ = {0,1,+,=} and ADD = {x=y+z | x,y,z are binary integers and x is the sum of y and z}.Show that ADD is not regular.
3. The pumping lemma says that every regular language has a pumping length p, such that every string in the language can be pumped if it has length p or more. If p is a pumping length for the language A,so is any length p` >= p.The minimum pumping length for A is the smallest p that is a pumping length for A.For example, if A = 01^*, the minimum pumping length is 2 . The reason is that the string s=0 is in A and has length 1 yet s cannot be pumped , but any string in A of length 2 or more containa a 1 and hence can be pumped by dividing it so that x = 0 ,y=1 and z is the rest. For each of the following languages,give the minimum pumping length and justify your answer.

    a. 1*01*01*
    b. (01)*
    c. 1011
    d. 001 $\cup$ 0*1*
4. To show that Language contains equal numbers of a and b, if we select the string w as follows, what could the adversary do in each case?

a. $w = (ab)^m$
b. $w = a^{m/2}b^{m/2}$

5. Show that the following languages over {a, b} are not regular:

a. $\{a^n ba^n : n \geq 1\}$.

b. $\{a^n : n$ is a perfect cube $\}$.

c. $\{w : \#a(w) < \#b(w)\}$.

d. $\{wb^n : w \in \{a, b\}*, Length(w) = n\}$.

e. $\{(ab)^m b^n : m > n \geq 0\}$.

f. $\{a^m b^n : m \ n, m.n \in N\}$.

g. $\{a^m b^n a^k : k \geq m + n\}$.

h. $\{a^n b^{2n} : n \geq 1\}$.

i. $\{a^m b^n : 0 < m < n\}$.

j. $\{a^m b^n a^k : k \neq m + n\}$.

k. $\{a^m b^n a^k : m = n$ or $n \neq k\}$.

l. $\{a^m b^n : m \leq n\}$.

m. $\{w \in \{a, b\}* : \#a(w) \ \#b(w)\}$.

n. $\{ww : w \in \{a, b\}*\}$.

o. $\{w^R w : w \in \{a, b\}*\}$.

p. $\{wwww^R : w \in \{a, b\}*\}$.

q. $\{a^m b^n : m > n\} \cup \{a^m b^n : m + 1 \neq n\}$.

r. $\{uww^R v : u, v, w \in \{a, b\}^+\}$.

s. $\{ww^n v : v, w \in \{a, b\}^+, n \geq 1\}$.

t. $\{ww : w \in \{a, b\}*\}$, where w is the string obtained from w by changing a to b, and b to a simultaneously.

6. Are the following languages over {a} regular?

   a. $\{a^n: n = m\ 2$ for some $m \in N\}$.

   b. $\{a^n : n = 2\ m$ for some $m \in N\}$.

   c. $\{a^{p-1} : p$ is a prime number$\}$.

   d. $\{a^{mk} : m$ and k are prime numbers$\}$.

   e. $\{a^n: n$ is either a prime or a product of two or more primes$\}$.

7. Show that the set of balanced parentheses is not a regular language.

8. Let L be a regular language. Consider the two languages:

   L 1 = $\{w : w^n \in L$ for some $n \in N\}$ and L 2 = $\{w^n : w \in L$ for some $n \in N\}$.

   Which one of L 1 , L 2 is regular and which is not? Justify.

9. Are the following languages regular?

   a. $\{uww^R v : u, v, w \in \{a, b\}^+(u) \geq (v))\}$.

   b. $\{a^m ba^n ba^{m+n} : m, n \geq 1\}$.