# PES UNIVERSITY, Bangalore

(Established under Karnataka Act No. 16 of 2013)

## Department of Computer Science & Engineering

## Automata Formal Languages & Logic

### Question Bank - Unit 2

### Questions from the Prescribed Textbook

| Topic | Exercise No. | Question No's |
|---|---|---|
| **Properties of Regular Language** | **4.1** | **Q1-Q26** |
| **Decidable Properties of Regular Languages** | **4.2** | **Q1-Q15** |

### Extra Questions

1. Give algorithms to determine whether for a given pair of finite automata:
   a) they both accept the same language
   b) the intersection of their languages is empty
   c) the intersection of their languages is finite
   d) the union of their languages is finite
   e) the intersection of their languages is infinite
   f) the union of their languages is infinite
   g) the intersection of their languages is $\Sigma^*$
   h) the difference of their languages is finite.
2. Give a construction of a product automaton for proving that union of two regular languages are regular.
3. What happens to the acceptance of languages when we interchange the final and nonfinal states of an NFA?
4. Show that there is no DFA that accepts all (and only) palindromes over {a, b}
5. Let D be the transition diagram of a DFA M. Prove the following:
   (a) If L(M) is infinite, then D must have at least one cycle for which there is a path from the initial vertex to some vertex in the cycle, and a path from some vertex in the cycle to some final vertex.
   (b) If L(M) is finite, then there exists no such cycle in D.

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6. Let B = {$a^k$| where k is a multiple of n}. Show that for each n>=1, the language B is regular.
7. Let C ={x|x is a binary number that is a multiple of n}. Show that for each n>1, the language C is regular.
8. Let A/B ={w|wx ∈ A for some x ∈ B}. Show that if A is regular and B is any language then A/B is regular.
9. 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) {$0^n1^m0^n$ | m,n >=0}
   b) {wtw | w,t ∈ $\{0,1\}^*$}
10. Let Σ = {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.
11. Prove that if L is regular then Prefix(L) is regular. Prefix(L) is the set of all strings which are a proper prefix of a string in L.
12. Prove that Regular Sets are closed under MIN. MIN(R), where R is a regular set, is the set of all strings w in R where every proper prefix of w is in not in R. (Note that this is not simply the complement of PREFIX).
13. Prove that Regular Sets are NOT closed under infinite union. (A counterexample suffices)
14. Prove that Regular Sets are NOT closed under infinite intersection.
15. Are the following statements true or false? Explain your answer in each case. (In each case, a fixed alphabet is assumed.)
    a. Let L`= L1 ∩L2. If L is regular and L2 is regular, L1 must be regular.
    b. Every subset of a regular language is regular.
    c. If L is regular, then so is L` = {xy : x ∈ L and y∉ L}
    d. If L is a regular language, then so is L= {w : w ∈ L and $w^R$ ∈ L}.
    e.
16. We know that the concatenation of two regular languages is a regular language. Consider the language $L$= $0^n1^n$ over {0, 1}; $L$ is not regular. Now consider, the language $L_1$ = {$0^n$} = 0* and $L_2$ = {$1^n$} = 1*. $L_1$ and $L_2$ are obviously regular. Explain why although $L_1$and $L_2$ are regular, $L$ which could be seen as a concatenation of $L_1$ and $L_2$ is not regular.

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17. What happens if we apply the Pumping Lemma to show that a formal language such as $((a + b)(a + b)(a + b))^*$ that actually regular is not regular? Explain.
18. **Using closure properties of regular languages, construct a finite automaton (NFA or DFA) for:**
    a. Binary strings which when interpreted as positive integers are not divisible by 3.
    b. Strings over $\{a,b\}$ that do not contain two consecutive $a$ s.
19. **Using closure properties of regular languages, show that the following languages are regular:**
    a. Binary strings that do not contain the substring 101.
    b. Binary strings are made up of two parts; the first part begins with a 1 and ends with a 0; the second part begins and ends with a 1.
    c. Binary strings which when reversed represent positive integers that are divisible by 3.
    d. Strings over $\{a,b, c\}$ whose length is neither an even number nor divisible by 3 or 5.
20. What is the reversal of the given language L be defined by regular expression $01^*+10^*$.
21. Is the class of languages recognized by NFAs closed under complement? Explain your answer
22. True or False: Regular expressions that do not contain the star operator can represent only finite languages.