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# *CS432 - Computation Theory*

***Assignment #1***

***4CS-S5***

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# Regular Expressions

## Find a regular expression to describe each of the following five languages

## Solution

### 

### Find a regular expression over the alphabet (0, 1) to describe the set of all binary numerals without leading zeros (except 0 itself). So, the language is the set (0, 1, 10, 11, 100, 101, 110, 111, ...).

## Solution

### Find a regular expression for each of the following languages over the alphabet (a,b).

## Solution

### d .

### Describe in English phrases the languages associated with the following regular expression:

## Solution

### Strings must include an **odd number of b’s**.

### String’s length must be .

### String in which the letters b , a is never doubled , This means that **no word contains the substring aa** .

### Construct a regular expression defining each of the following languages over the alphabet {a b}:

## Solution

### Describe (in English phrases) the languages associated with the following regular expressions:

## Solution

### Strings must include at **least a** and will never end with any number of b’s **excluding 4 b’s**.

### Strings may be **empty** or , **start with a and end with a or bb.**

### Strings may be **empty** or **start with a** **and have odd number of a’s and b’s**.

### Strings may be **empty** or have **an odd number of a’s**.

### Strings may be **empty** or **consist of a’s only or b’s only** or consist of a’s and b’s **but occurrences of contagious a’s and contagious b’s are not even** .

### Strings may be **empty** or **have even length and end with a**

### Show that the following pairs of regular expressions define the same language over the alphabet {a,b}:

## Solution

### These regular expressions are equals and match the same strings that consist of ababab….aba , match with first regular expression as : (ab)(ab)(ab)….(ab)a , match with second regular expression as: a(ba)(ba)(b….a)(ba)

### These regular expressions are equals and match the same strings that consist of any number of a’s and b’s in any order as : aaabbaa match first regular expression as : (aaa)(b)(b)(aa)

### and match second regular expression as : (a)(a)(a)(b)(b)(a)(a)

### These regular expressions are equals and match the same strings that consist of any number of a’s and b’s in any order as : aaabbaa match first regular expression as : (aaa)(bb)(aa) and match second regular expression as : (a)(a)(a)(b)(b)(a)(a)

### These regular expressions are equals and match the same strings that consist of any number of a’s and followed by number of b’s divisible by 3 then followed by any number of a’s as : aaaabbbbbbaa match with first regular expression as : ((aaaa)bbb)(bbb)(aa) and match second regular expression as : (aaaa)(bbb)(bbb(aa))

# Finite Automata

### **DFA**

### Transform each of the following regular expressions into a DFA.

## Solution

a , b

b

a

a

b

b

a,b

a

b

a

b

a

a,b

a

b

a

b

### Design a DFA that accepts all strings over {a, b}

### All strings that do not end with aa.

Regular expression :

a

b

a

b

b

a

### All strings that contain an even number of b’s

Regular expression :

a

a

b

b

### All strings which do not contain the substring ba

Regular expression :

a,b

b

b

a

a

### **NFA**

### Draw NFA for each of the following languages over the alphabet {a,b}

### All strings that contain two a’s separated by a substring whose length is a multiple of 3.

Regular expression :

a , b

a , b

a , b

a , b

a

a , b

a

a

### All strings that contain an even number of b’s.

Regular expression :

£

b

b

a

a

£

### All strings which do not contain the substring ba.

Regular expression :

£

b

a

### **NFA to DFA**

### **Q1**

b

a , b

|  |  |  |
| --- | --- | --- |
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|  |  |  |
|  | **⎯** | **⎯** |

DFA

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| --- | --- | --- |
|  |  |  |
|  |  |  |
|  |  |  |
|  | **⎯** | **⎯** |

NFA

a , b

**Q2**

a

a , b

a , b

DFA

NFA

|  |  |  |
| --- | --- | --- |
|  |  |  |
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|  |  | ⎯ |
|  |  |  |

b

a

a , b

a , b

**Q3**

b

b

a

a , b

|  |  |  |
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|  |  |  |
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|  | − |  |
|  | − | − |

NFA

DFA

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|  |  |  |

b

b

a

ab

a

a

b

a , b

**Q4**

a

a , b

a , b

a

NFA

|  |  |  |
| --- | --- | --- |
|  |  |  |
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|  | − | − |
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|  |  |  |

DFA

b

b

b

a

a

a