Nathan Brooks  
Homework 01  
CS 4110  
Due September 7, 2016

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***Consider the language S \*, where S = {aa aba baa} ,***

**P01.a (3 points) is “baaabaaa” in the language? Why?**yes   
because **baa aba aa** are in the language. Concatenating these together we get **baa aba aa**   
which equals **baaabaaa**

**P01.b (3 points) is “baaaaababaaaa” in the language? Why?**yes  
because separated out **baa aa aba baa aa** are in the language

**P01.c (3 points) is “abaabaabaaaa” in the language? Why?**no  
because **aba aba aba aa** are in the language but **a** is not, or  
because **aba aba aba** are in the language but **aaa** is not.  
There is no way to make this string of letters.

**P01.d (3 points) is “baaaaaaaabbabaaaaa” in the language? Why?**no  
**baa aa aa aa** are in the language but there is no way to make the next part, **bbabaaaaa**,using this language, cannot make **bb** using this language

**P01.e (3 points) Can any word in this language have a substring of “bb” or an odd total number of a’s? why?**no you cannot make **bb** because there are no substrings that end in **b** and there are only single **b**s in these substrings  
no you cannot have an odd total number of **a**s because all substrings have an even number of **a**s

**P02. Recursive Definition (8 points)**

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| On page 13 in the Textbook, a language called **PALINDROME** is defined over the alphabet Σ = {a, b} :  **PALINDROME** = { Λ , and all strings x such that reverse( x ) = x }  When asked to give a recursive definition for the language **PALINDROME** over the alphabet Σ ={a, b} , a student wrote:  **Rule 1**: **a** and **b** are in PALINDROME  **Rule 2**: If x is in **PALINDROME**, then so are **axa** and **bxb**  Unfortunately, all the words in the language defined above have an odd length and so it is not all of PALINDROME.  Fix this problem (4 points) and explain why (4 points). |

There are 2 ways to fix this.  
  
**First:** Rule 1 should also denote **Λ** as being in the alphabet Σ

**Rule 1**: **a**, **b, and Λ** are in PALINDROME

If you start with a null string, rule 2 can make even PALINDROMES

**Second:** Rule 2 should read “all strings **x** in **PALINDROME** must equal the reverse of itself aka **x** = reverse(**x**)”  
 this will take care of all even and odd cases.

**P03. Regular Expression (7 points)**

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| Construct a regular expression for all words in which **a** appears tripled, if at all. This means that every clump of **a**’s contains 3 or 6 or 9 or 12… a’s. For example, b, bb, bbb, baaa, aaabbaaa, aaaaaaaaa, are all in this language. |

(a**3**)\* - can contain any number of 3 groupings of **a**, including no clumps

( b\* (a**3**)\* ) - can contain any number of **b**s before the **a** clumps, including none

( b\* (a**3**)\* )\* - can be repeated any number of times, or no times