Homework #1
COMP 3200
Fall 2023
Prof. Stucki

Your answers should be typed or neatly written on clean paper.

1) Determine whether each of the following is true or false.

   a) $\varnothing \subseteq \varnothing$
   b) $\varnothing \in \varnothing$
   c) $\varnothing \in \{\varnothing\}$
   d) $\varnothing \subseteq \{\varnothing\}$
   e) $\varepsilon \subseteq \{\varepsilon\}$
   f) $\varepsilon \in \{\varepsilon\}$
   g) $\{\varepsilon\} = \varnothing$
   h) $\{a, b\} \in \{a, b, \{a, b\}\}$
   i) $\{a, b\} \subseteq \{a, b, \{a, b\}\}$

2) For each of the following languages, list three strings (if possible) in the language, and then list three strings (if possible) not in the language. For each language $\Sigma = \{a, b\}$.

   a) $\{w : w$ has an even length$\}$
   b) $\{w : w$ contains either the substring *abbb* or the substring *aa*$\}$
   c) $\{w : w$ has twice as many *a*'s as *b*'s$\}$
   d) $\{w :$ for some $u, v \in \Sigma^*, uvw = wvu\}$
   e) $\{w : ww = www\}$
   f) $\{w :$ for some $u \in \Sigma^*, www = uu\}$

3) For each of the languages in question 2, determine whether the empty string, ε, is in the language.

4) For each pair of languages, A & B, below show the languages produced by taking the union ($A \cup B$), and the concatenation (AB).

   a) A = {a} B = {b}
   b) A = {cubs, cardinals, pirates, reds, brewers} B = {nets, nationals, braves, marlins, phillies}
   c) A = {a, abb, bbab, babab, bb} B = {a, b, aa}

5) For each of the regular expressions, describe in English the language that it represents.

   a) a*b
   b) (a + b + aa + ab + ba + bb)
   c) (a + b)*aa
   d) (a + b)(a+b)*