Assignment 3 and 4 – CS 301 - Theory of Automata – Fall 2020

Due: Wednesday, November 11, 2020 (online – 11 PM)

Note: Late submissions will have 25% deduction. Submission after Friday (Nov 13 – 2 PM) will not be accepted.

Assignment 3 [Total marks = 50]

1. **[8 * 5]**
   Define CFGs for the following languages. For parts a-g, set of terminals is {a, b}. For part h, set of terminals is {a, b, c}.

   Note that a and b are regular languages. Therefore, grammar generated for a and b will be considered regular grammar. In this question, do not make DFA and then make grammar for these two languages.

   a. A = { w ∈ {a, b}* | All words in which the letter b is never tripled}

   b. B = { w ∈ {a, b}* All words that do not have the substring abb}

   c. C = { w ∈ {a, b}* | number of a's and number of b's are equal}

   d. The language D of strings of properly balanced left and right brackets: every left bracket can be paired with a unique subsequent right bracket, and every right bracket can be paired with a unique preceding left bracket. Moreover, the string between any such pair has the same property.
   For example, [ ] [[[ ] [ ]] [ ]] ∈ D.

   e. E = $\{a^n b^m a^{2n} \mid n, m > 0\}$

   f. F = $\{ a^n b^m a^k \mid k = m + 2n\}$

   g. G = $\{a_i b_j \mid 3i \leq j \leq 4i \}$

   h. H = { w ∈ {a, b,c}* | number of a's and number of b's are equal or number of b's and number of c's are equal}

2. **[10]**
   In this question, you shall be designing grammar for Roman Number System from 1 – 399.
   For this question, your set of terminals is {i, v, x, l, c}.
   In Roman number system, i stands for 1, v stands for 5, x stands for 10, l stands for 50 and c stands for 100.
   More information about Roman Numbers can be found at Wikipedia.

Assignment 4 [Total Marks = 30]

1. [30] Convert the following CFGs to CNF form
   a. S → ASB
   A → aAS | a | ε
   B → SbS | A | bb

   b. S → aTXb
   T → XTS | ε
   X → a | b

   c. S → aAA
   A → aS | bS | a