

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. $A = \{ w \in \{a, b\}^* \mid \text{All words in which the letter b is never tripled} \}$
- b. $B = \{ w \in \{a, b\}^* \mid \text{All words that do not have the substring abb} \}$
- c. $C = \{ w \in \{a, b\}^* \mid \text{number of a's and number of b's are equal} \}$
- 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, $[] [[[]]] []] \in D$.
- 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. $H = \{ w \in \{a, b, c\}^* \mid \text{number of a's and number of b's are equal or number of b's and number of c's are equal} \}$

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. $S \rightarrow ASB$

$$A \rightarrow aAS \mid a \mid \varepsilon$$

$$B \rightarrow SbS \mid A \mid bb$$

b. $S \rightarrow aTXb$

$$T \rightarrow XTS \mid \varepsilon$$

$$X \rightarrow a \mid b$$

c. $S \rightarrow aAA$

$$A \rightarrow aS \mid bS \mid a$$