## CSE331: Automata and Computability Worksheet 5 (CNF and CYK and Turing)

Convert the following context free grammars to its equivalent CNF (Chomsky Normal
Form) and then use the CYK algorithm to check if the given string belongs to the grammar or not.

a) 
$$S \rightarrow A 1 B$$

$$A \rightarrow 0A \mid \varepsilon$$

$$B \rightarrow 0B |1B| \varepsilon$$

String for CYK: 01011

b) 
$$S \rightarrow aSa \mid aBa$$

$$B \rightarrow bB \mid b$$

String for CYK: abbb

$$A \rightarrow aA \mid \epsilon$$

$$B \rightarrow bB \mid \epsilon$$

$$C \rightarrow cC \mid \epsilon$$

$$E \rightarrow aEc \mid F$$

$$F \rightarrow bFc \mid \epsilon$$

$$U \rightarrow aUc \mid V$$

$$V \rightarrow bVc \mid bB$$

String for CYK: aabcc

$$d) S \rightarrow aSbb \mid Z$$

$$Z \rightarrow aZb \mid \epsilon$$

String for CYK: aab

$$Z \rightarrow aaZb \mid \epsilon$$

String for CYK: aab

**2.** M is a Turing Machine with following description:

$$\begin{split} M = (Q, \Sigma, \Gamma, \delta, q_1, B, q_{accept}), \\ Q = \{q_1, q_2, q_3, q_4, q_5, q_6, q_7, q_8, q_{accept}\}, \ \ \Sigma = \{0, 1, \#\} \ , \\ \Gamma = \textit{all symbols on tape} = \{0, 1, \#, x, B\} \ \ , \text{where } B = Blank \ space \end{split}$$

Note:  $0/x \rightarrow$  means replace 0 with x and move right,  $0/x \leftarrow$  means replace 0 with x and move left.

- a) Simulate the following turing machine for the input 110#110
- b) Will the machine accept the string?
- c) Describe the language of the machine.

