

Fall-2024 CS-Department

Assignment 2

Course Code: CS301

Course Name: Theory of Automata

**Question 1:** Use the Example on **page 110 of Sipser 3rd edition** book to convert the following grammars into Chomsky normal form (CNF).

$$1. S \rightarrow ABA$$

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

$$B \rightarrow bBc \mid \epsilon$$

$$2. S \rightarrow Xa$$

$$B \rightarrow aX \mid bX \mid \epsilon$$

$$3. S \rightarrow aSa \mid bSb \mid b|a|aa|bb$$

**Question 2:** Convert the grammars in **Q1** to corresponding PDAs.

**Question 3:** Give a Pushdown Automata that recognize the following languages.

- $A = \{w \in a, b^* \mid w \text{ contains at least three } a\text{'s}\}$
- For a given Language  $B = \{w \in a, b^* \mid w = w^R \text{ where the length of } w \text{ is odd}\}$
- For a given Language  $C = \{01^n 0c01^n \mid n \geq 0\}$

**Question 4:** Consider the following CFG  $G = (V, \Sigma, R, E)$ , where  $V = \{E, T, F\}$ ,  $\Sigma = \{a, b, +, x, (, )\}$ , The start symbol is  $E$  and production rules are defined by  $R$  are as follows:

$$E \rightarrow E + T \mid T$$

$$T \rightarrow T x F \mid F$$

$$F \rightarrow (E) \mid a$$

- Construct an equivalent PDA for  $G$ .
- Trace string ' $(a + a) x a$ ' while showing either all the updates in stack **OR** instantaneous description.

**Question 5:** Give a Pushdown Automata that recognize the following language and also show complete computation of any one word (of your choice) of below language.

$$L = \{a^{2n} b^{3n} \mid n \geq 0\}$$