



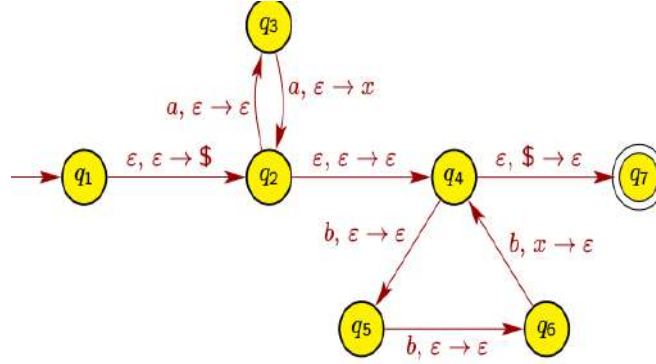
United International University
Department of Computer Science and Engineering
 CSE 2233/CSI 233: Theory of Computation/ Theory of Computing
 Final-Exam: Fall'19 Time: 2:00 Hours Marks: 40

1. (a) Draw push down automaton (PDA) for the following languages: [4+4]

$$L = \{a^n b^m \mid n, m \geq 1 \text{ and } n \neq m\}$$

$$L = \{a^m b^n \mid \text{where } n < m \leq 2n\}$$

- (b) Consider the following push down automaton (PDA) [4]



- (i) What is the language of the PDA ?
 - (ii) What are the input alphabet of the PDA ?
 - (iii) What are the stack alphabet of the PDA ?
 - (iv) Write two strings that the PDA accepts.
2. Give context-free grammars (CFG) that generate the following languages : [3+3=6]
- (a) $L = \{w \mid \text{the length of } w \text{ is odd and its middle symbol is a } 0\} \text{ and } \Sigma = \{0, 1\}$
 - (b) $A = \{a^i b^j c^k \mid \text{where } i = j \text{ or } j = k \text{ and } i, j, k \geq 0\} \text{ and } \Sigma = \{a, b, c\}$
3. Consider the following context-free grammar (CFG). [2+2+2=6]

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

$$T \rightarrow T \times F \mid F$$

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

Now give parse trees and left-most derivations for each of the following.

- (a) $a + a$
 - (b) $a \times a + a$
 - (c) $((a))$
4. Convert the following context-free language (CFG) to Chomsky Normal Form (CNF) [6]

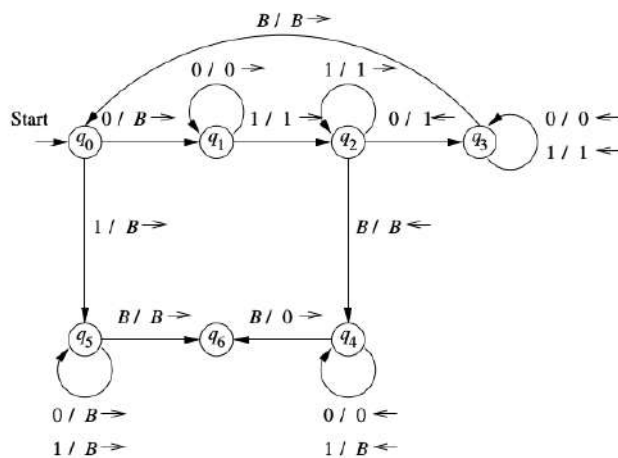
$$S \rightarrow ASB$$

$$A \rightarrow aAS \mid a \mid \epsilon$$

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

5. Consider the following Turing Machine.

[2+4+4=10]



- Find out the language that is recognized by the Turing Machine
- Write down the transition table for the Turing Machine.
- Write down three strings that the Turing Machine accepts and three strings that the machine rejects.