



AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH

Faculty of Science and Technology

Department of Computer Science

CSC 3113 Theory of Computation (Section: ALL)

Final Term Examination**Summer 2021-2022****Total Marks:** 100 **Moderator:** Sharfuddin Mahmood**Time:** 1.5 hours**General Instructions:**

1. Return the question paper at the end of the examination.
2. Use pencil / pen to write the answer and to draw diagrams.
3. Marks on the right margin indicate full marks.

| | | | |
|---------|--|-------------------|--|
| Name | | ID | |
| Section | | Proctor's Sign | |
| Date | | | |

1. Write the Context-free grammar for **Any TWO** of the following languages where $\Sigma = \{x,y\}$ 10*2=20
 - i. $A = \{ w \mid \text{each 'x' in } w \text{ is followed by at least two 'y' } \}$
 - ii. $A = \{ w \mid \text{starts and ends with same symbols } \}$
 - iii. $A = \{ w \mid w \text{ contains 'xyxyxy' as substring} \}$

2. Convert following Context free grammar to Chomsky normal form. Show all the steps.

20*1=20

$$D \rightarrow xDx \mid yE \mid \epsilon$$

$$E \rightarrow yEy \mid xF \mid \epsilon$$

$$F \rightarrow xD \mid \epsilon$$

3. Design Push Down Automata for the following language. (**Any One**)

20*1=20

i. $A = \{a^i b^j c^k \mid \text{where } i+j = k \text{ and } i, j, k \geq 1\}$

ii. $A = \{a^m b^n \mid \text{where } m = 2n \text{ and } m, n > 1\}$

4 Consider a Turing machine with the following transitions.

20

| State | Input | $\delta(\text{State, Symbol, Move})$ |
|-------|-------|--------------------------------------|
| Q_0 | a | $Q_1, \#, R$ |
| Q_0 | # | $Q_{\text{accept}}, \#, R$ |
| Q_1 | a | Q_1, a, R |
| Q_1 | b | Q_2, x, R |
| Q_1 | x | Q_1, x, R |
| Q_2 | a | Q_3, x, R |
| Q_2 | b | Q_2, b, R |
| Q_2 | x | Q_2, x, R |
| Q_3 | a | Q_4, a, L |
| Q_3 | # | $Q_6, \#, L$ |
| Q_4 | a | Q_4, a, L |
| Q_4 | b | Q_4, b, L |
| Q_4 | x | Q_4, x, L |
| Q_4 | # | $Q_5, \#, R$ |
| Q_5 | a | Q_1, x, R |
| Q_5 | x | Q_5, x, R |
| Q_6 | x | Q_6, x, L |
| Q_6 | # | $Q_{\text{accept}}, \#, R$ |

Here ' Q_0 ' is the start state, ' Q_{Accept} ' is the accept state. Trace the execution of this Turing machine with the string **aabbbaa#** as input. Note that '#' represents the blank symbol.

6 Write down the formal definition of Push Down Automata.

5

- 7 Read the algorithm carefully. Then design the Implementation Level Strategy for the algorithm. Describe how you are going to use the tape for designing the Turing Machine. 15

Algorithm:

For every 'a'

 replace next 'a' from left by X

 replace next two 'b' from left by Y

End for

if

 for each 'a' there is **one** or **more than two** 'b', then REJECT

Else if

 All 'a' and 'b' are marked, then ACCEPT