National University of Computer and Emerging Sciences, Lahore Campus

	Course:	Theory of Automata	Course Code:	CS-2207
	Program:	BS(Computer Science)	Semester:	Fall 2017
	Duration:	3 Hours	Total Marks:	70
	Paper Date:	11-12-17	Weight	45%
	Section:	A,B,C,D,E,F	Page(s):	10
			Roll. No:	
	Exam:	Final Exam	Section:	

Instruction/Notes:
- All the questions are to be attempted on this question paper
- You can use rough sheet but answers and working should be shown on this question paper.
- You must show working for all the questions, no marks will be given without proper working.
- Please don't attach any extra sheet with the question paper.

Question 1: Part (a) [marks 10]

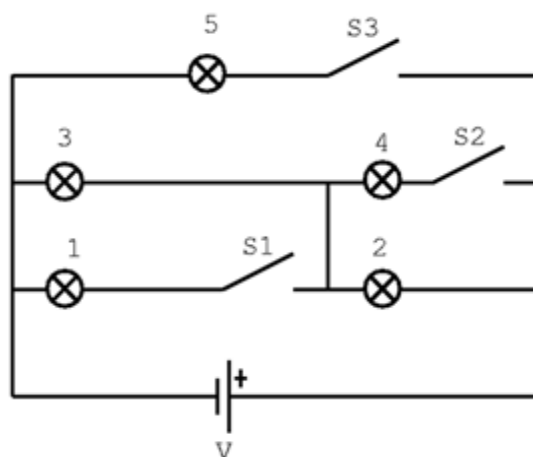### Construct A Deterministic Finite Automata:

Figure 1A

Above diagram shows a circuit having three pushbutton switches and 5 bulbs. Each bulb is turned on if its corresponding circuit is closed. You are to create DFA of the above circuit. The states of the DFA should reflect the state switches (i.e. on or off). Initial state of your DFA should be such that all bulbs are off, and final state should be such that only bulb 3 and 2 are turned on. Input of your DFA will belong to {S1, S2, S3}*.

Sample input: S1 S2 S2 S3 S1 S2

Which means first S1 is pressed then two times S2 is pressed then S3, S1 and finally S2 is pressed. On each press of a switch its state will be toggled. i.e. if switch was off it will be turned on and vice versa.

NOTE: consider S1 as one symbol, same for S2 and S3 as well.

Question 1: Part (b) [marks 10]

Minimal Automata

Minimize the DFA given in figure 1B, draw state diagram of your final DFA. Also show your working.
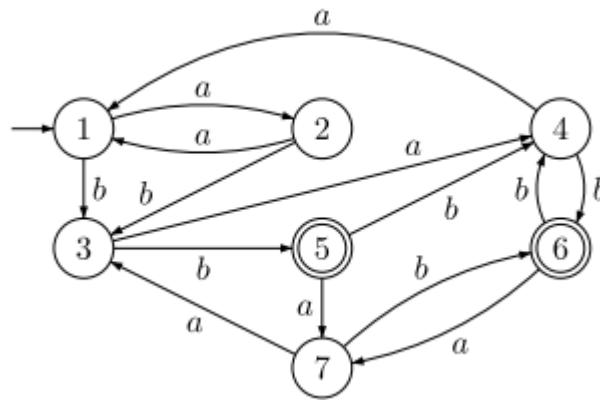

Figure 1B

Question 2: Part (a) [marks 10]

Context Free Grammar

Construct CFG (Context free grammar) of L_1 where L_1 is context free language.

L_1: { $a^n b^m c^k$| n>=m and k=n-m}

Question 2: Part (b) [marks 10]

Top down deterministic Parser

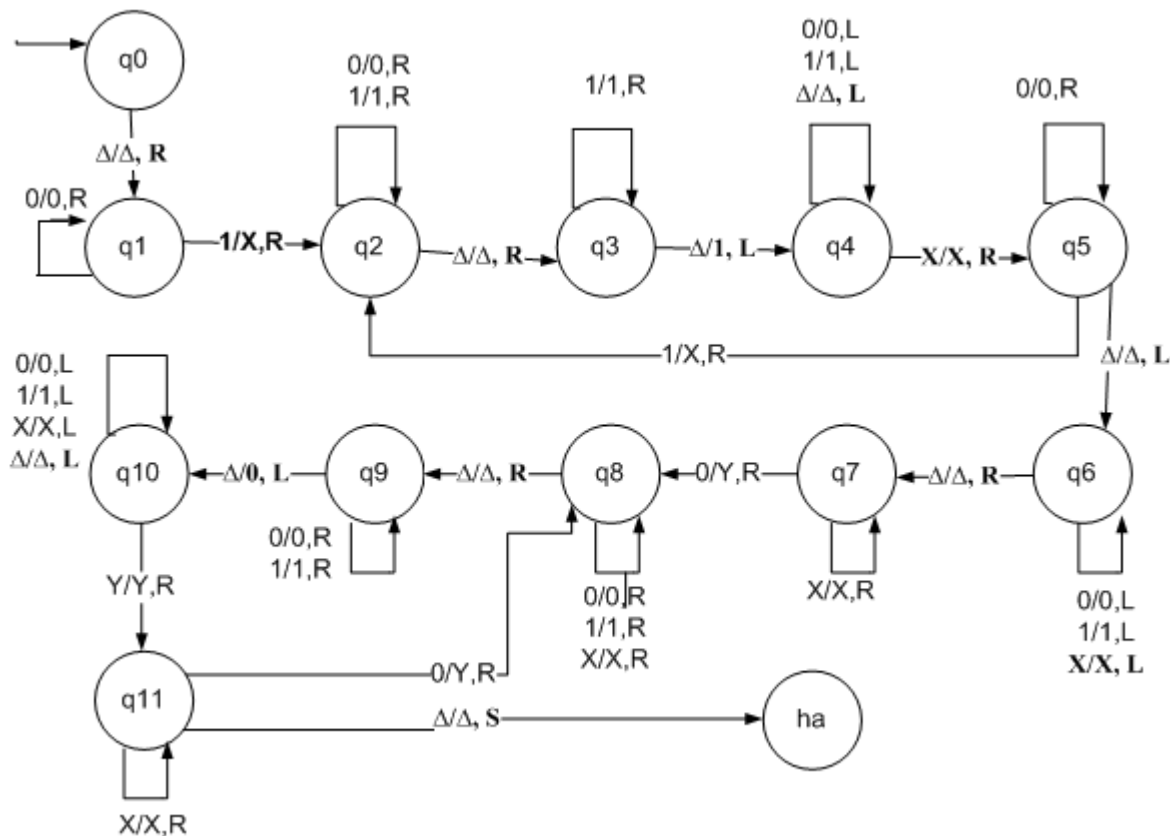Construct a Top down deterministic Parser for the following CFG.

S→ A#

A→aAbA| null

Note: # is same as $

Question 3: Part (a) [marks 10]

You are given with a single tape TM.

q0
Δ/Δ, R
0/0,R
q1 —1/X,R→ q2 —Δ/Δ, R→ q3 —Δ/1, L→ q4 —X/X, R→ q5

q2: 0/0,R 1/1,R
q3: 1/1,R
q4: 0/0,L 1/1,L Δ/Δ, L
q5: 0/0,R

—1/X,R—

q5 —Δ/Δ, L→ q6

0/0,L 1/1,L X/X,L Δ/Δ, L
q10 —Δ/0, L→ q9 —Δ/Δ, R→ q8 —0/Y,R→ q7 —Δ/Δ, R→ q6

q9: 0/0,R 1/1,R
q8: 0/0,R 1/1,R X/X,R
q7: X/X,R
q6: 0/0,L 1/1,L X/X, L

q10 —Y/Y,R→ q11

q11 —0/Y,R→ q8
q11 —Δ/Δ, S→ ha
q11: X/X,R

Output on given string: You have to run the TM on the string 111010101 (make sure input is enclosed between Δ's on TM).After processing what is the output of tape? (Show working)

Tape you are given:

Δ	1	1	1	0	1	0	1	0	1	Δ

Output Tape:

Description of TM: Briefly explain in words what it is doing (answer should be generic).

Question 3: Part (b) [marks 20]

Turing Machine

Given 2 Strings X and Y such that X,Y ϵ {a,b}$^+$

Construct a Turing Machine that outputs the number of times Y appears in X.

Your Turing machine will have 3 tapes. Tape 1 will have X as input, Tape 2 will have Y as input, and on Tape 3 you have to write the output. As your output is the number of times Y appears in X, it should be in unary form.

Following is an example of initial and final configuration of such Turing machine if X= **aaababab** and Y=**abab**.is given in figure 3B
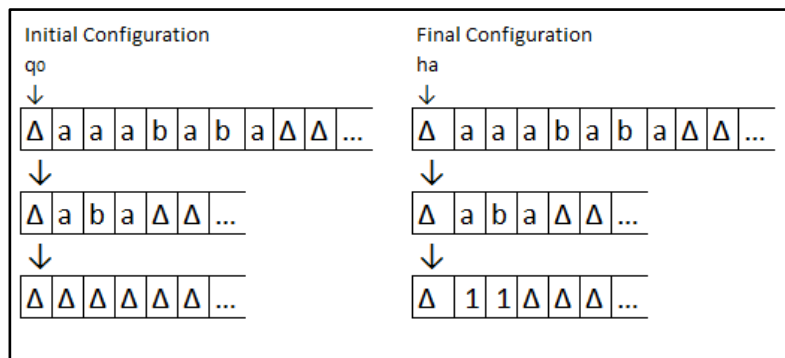

Figure 3B

NOTE: Output is 11 are there are two occurrences of Y in X (aaababab)

You also have to write a brief algorithm of your machine as well as create a state diagram.

Write your algorithm here: