Victoria University of Bangladesh
Department of CSE
Program: B.Sc in CSIT
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Course Title:- Theory of Computing
Course code:- CSI 317
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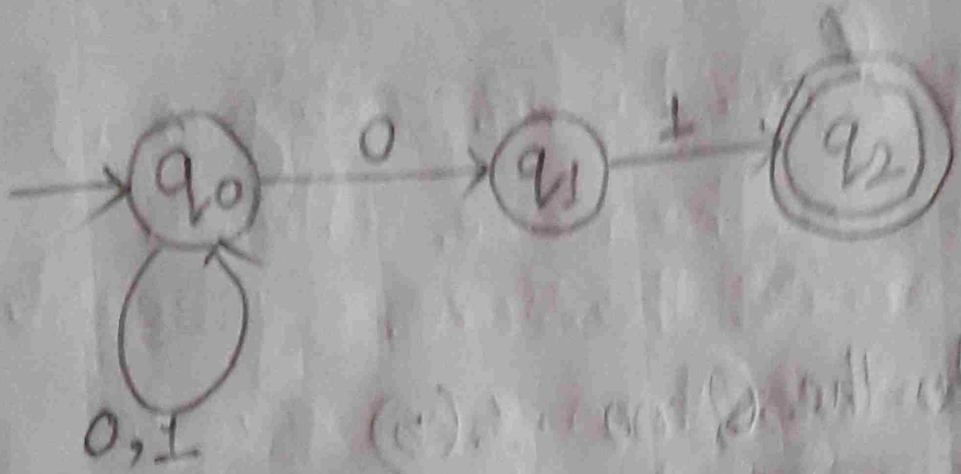
Batch:- 20

Ans to the Q. no - 1(a)

NFA that ends with 01



Here,

$Q = \{q_0, q_1, q_2\}$

$\Sigma = \{0, 1\}$

$F = \{q_2\}$

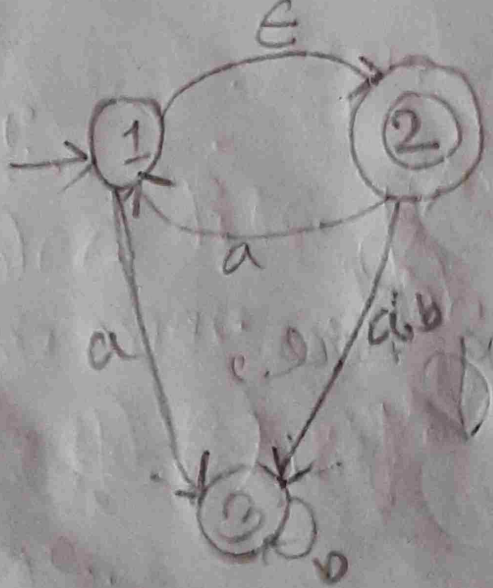
q_0 = initial state

Transition (δ) is showing here,

	0 , 1	
→ q_0	q_0, q_1	q_0
q_1	ϕ	q_2
q_2	ϕ	ϕ

Ans to the Q no - 1 (b)

Given NFA Fig →



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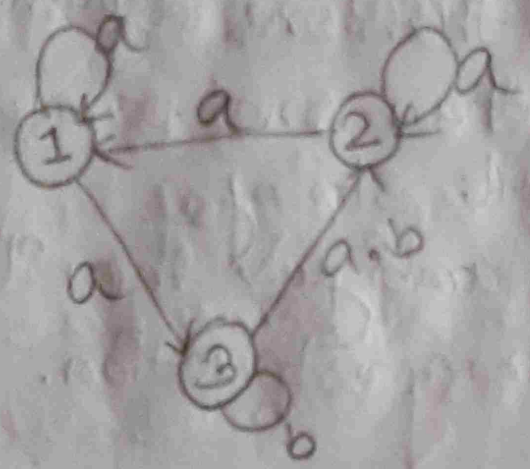
Transition table:-

	a	, b
1	1,3	ϕ
2	2,1	ϕ
3	2,	2,3



Ans to the Q no - 1(e)

Non-terminal are those symbols that can be replaced. The non-terminals define sets of strings that help define the the

Language generated by the grammar.

Ans to the Q no 4 (a)

[i] PDA for the language,

$$L = \{a^n b^n c^m \mid m, n >= 1\}$$

$$L = \{abc, abcc, abccc, aabbc, aabbbcc \ldots\}$$

We need to maintain the order of a's, b's and c's. That is, all the a's are coming first and then b's, ~~and~~ then c's. So, we need a stack along with the state diagram. The count of a's and b's is maintained by the stack. We will take two stack alphabets!

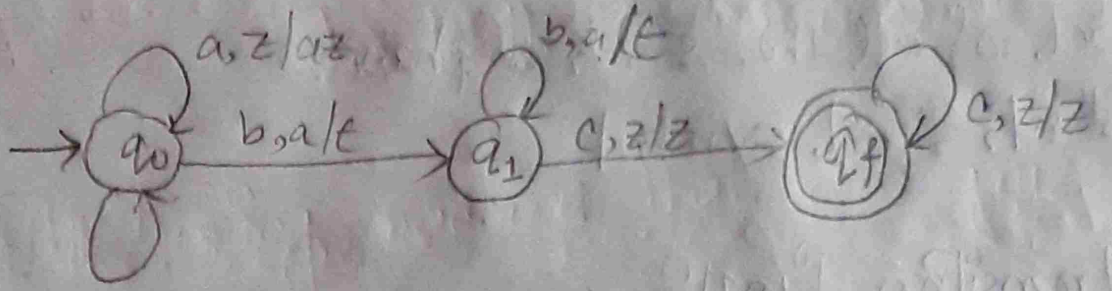
$$\Gamma = \{a, z\}$$

Γ = set of all the stack alphabet
z = stack start symbol

Stack transition function:-

$\delta(q_0, a, z) \vdash (q_0, az)$
$\delta(q_0, a, a) \vdash (q_0, aa)$
$\delta(q_0, b, a) \vdash (q_1, \epsilon)$
$\delta(q_1, b, a) \vdash (q_1, \epsilon)$
$\delta(q_1, c, z) \vdash (q_f, z)$
$\delta(q_f, c, z) \vdash (q_f, z)$

Where, q_0 = Initial state
q_f = Final state
ϵ = indicates pop operation

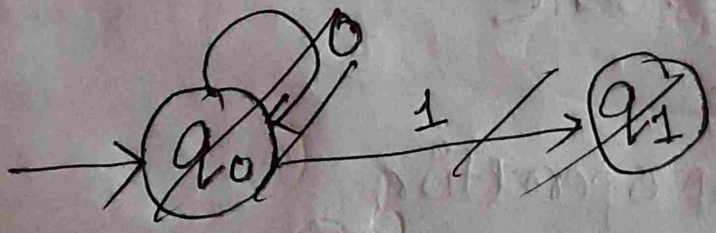


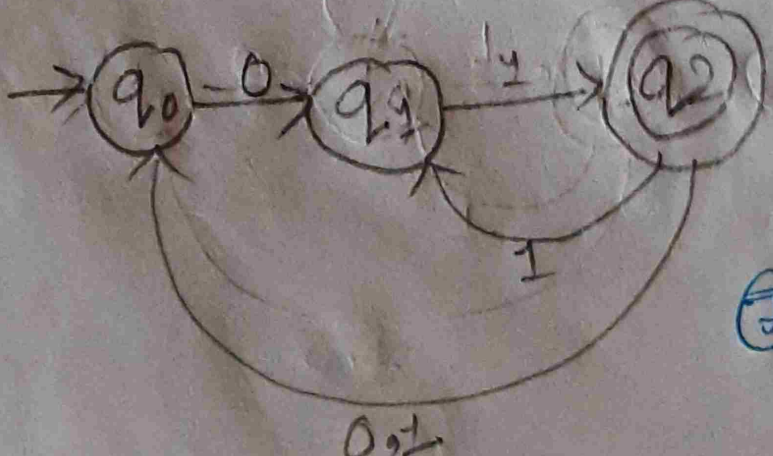
So, this is our required non deterministic PDA for accepting the language $L=\{a^n b^{2m} | m,n >= 1\}$

Ans to the Q no - 4(b)

L = {w. w is a binary string that contains 11 as a ~~sbst~~ substring}

$\Sigma = \{0, 1\}$





(7)

Ans to the Q no - 5(a)

Turing machine:-

A turing machine is an accepting device which accepts the languages generated by O grammars. It was invented in 1936 by Alan Turing.

A turing machine (TM) is a mathmatical model which consists of an infinite length tape divided into cells on which input is given.

Ans to the Q no 5(b)

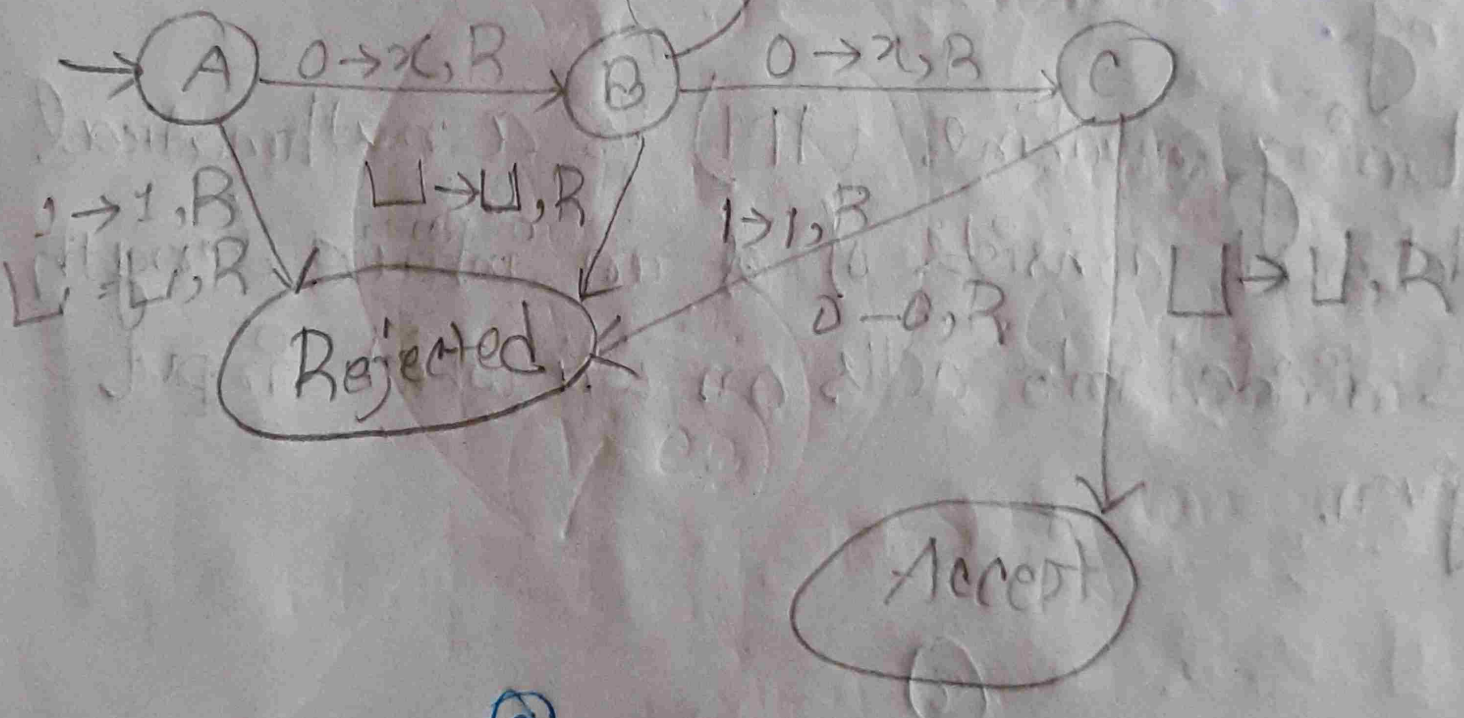
Turing machine that recognizes

$L = (0(0+1)^* 1)$

$\Sigma = 0\,1$

$1 \to 1, R$

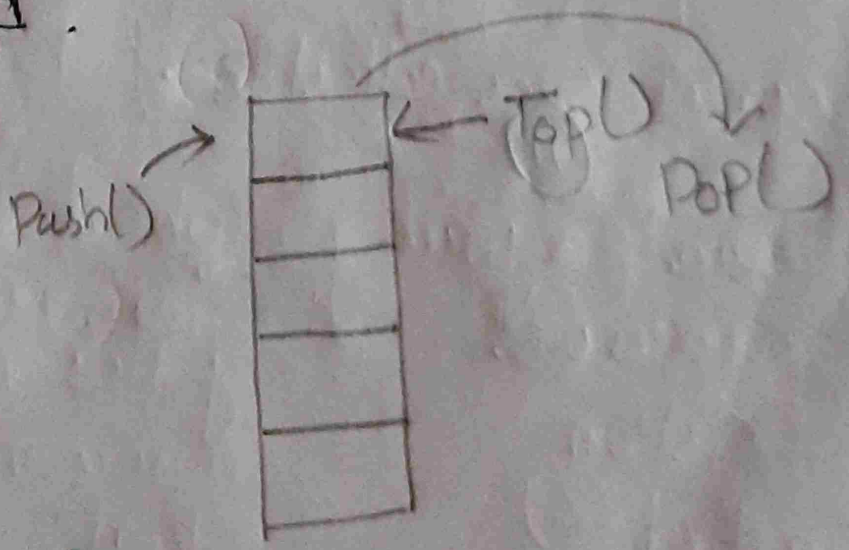
$b = \sqcup$



(a)

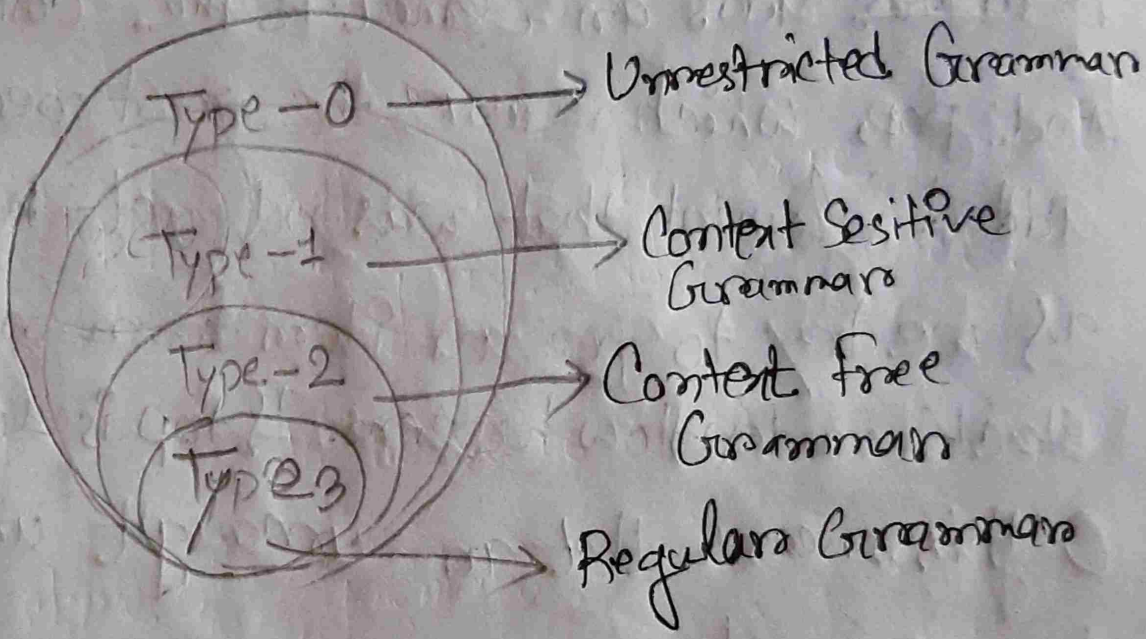
Ans to the Q no 5(c)

A stack is an abstract data type that serves as a collection of elements, with two principals operations: push, which ~~removes~~ adds an element to the collection, and: pops, which removes the most recently added element that was not yet removed. If we try to pop an item from an empty stack underflow happens. If top is less than 0 this means that an uncaught underflow has occured.



Ans to the Q no - 3(a)

The Chomsky Hierarchy, as originally by Noam Chomsky comprises four types of Languages and their relations →



Here is a visual diagram showing the relation between the four language:

Language	Grammar	Machine	Ex:-
① Regular Language	① Regular grammar ② Right linear ③ Left linear	Deterministic or non deterministic finite state accepter	a^*
② Context-free Language	Context free grammers	Nondeterministic push down automaton	$a^n b^n$
③ Context-sensitive Language	Context sensitive grammar	Linear bounded automaton	$a^n b^n c^m$
④ Recursively enumerable Language.	Unrestricted grammar	Turing machine	Any computable function

Ans to the Q.no - 36

Differences between Regular and Context free language

(3) Regular language is generated by regular grammars ~~this~~ which further produced by Finite automata.

Ex. a^*

(4) Context free language is generated by context free grammars produced by push down automata.

Ex. $a^n b^n$

Ans to the Q, no - 3(c)

DFA for the regular expression,

$R = 1^*00^*1(0+1)^*$