

④ Never blindly trust anything.

If you find any mistake, kindly correct it and if possible inform in our grp too.

Thank you
18BCE120.

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~~Always download from~~
So that If & you get most recent
and updated answers.

Update or Corrections will be
mentioned here.

31-03-2021 - Q.6 added.

03-03-2021 Q.6 update

5-5-21 Q.6 updated

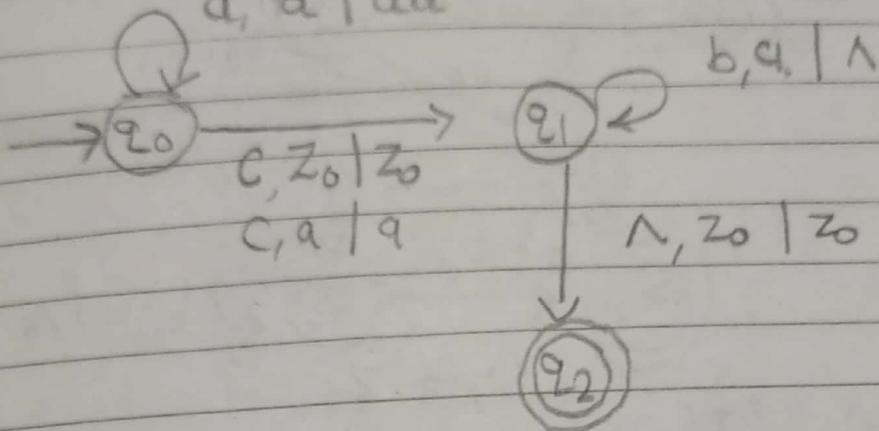
Tutorial 8

(2)

Design PDA:

$$2) L_1 = \{ a^m c b^m \mid m \geq 0 \}$$

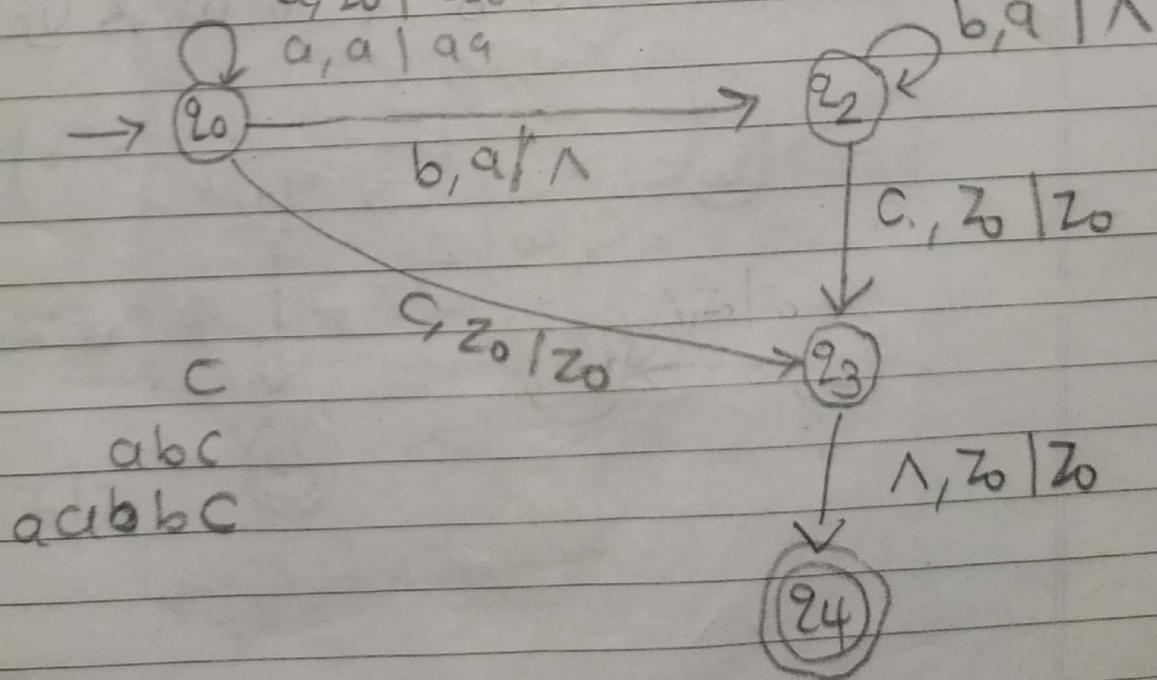
$a, z_0 \mid a z_0$
 $a, a \mid aa$



c
ac b
aac ba

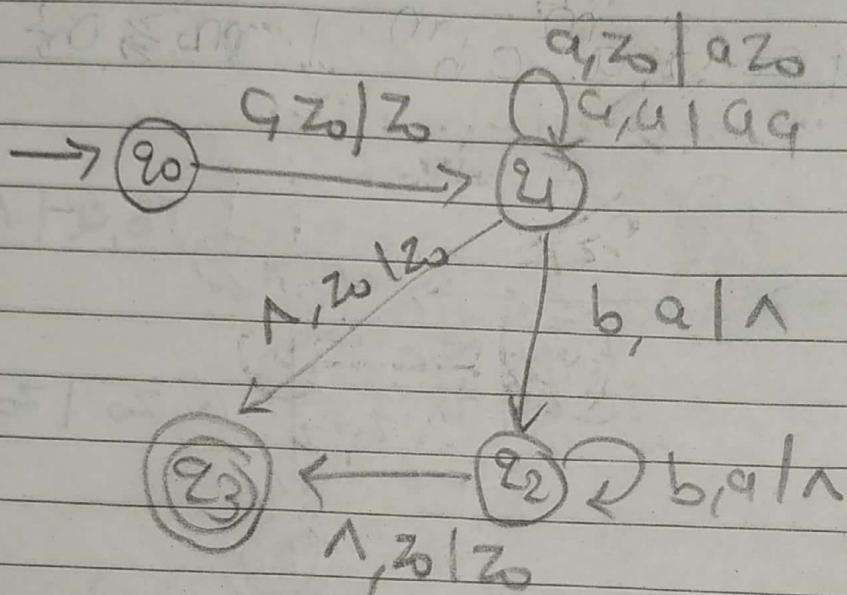
$$2) L_2 = \{ a^m b^m c \mid m \geq 0 \}$$

$a, z_0 \mid a z_0$
 $a, a \mid aa$



c
abc
acbbc

③ $L_3 = \{ c a^m b^m \mid m \geq 0 \}$

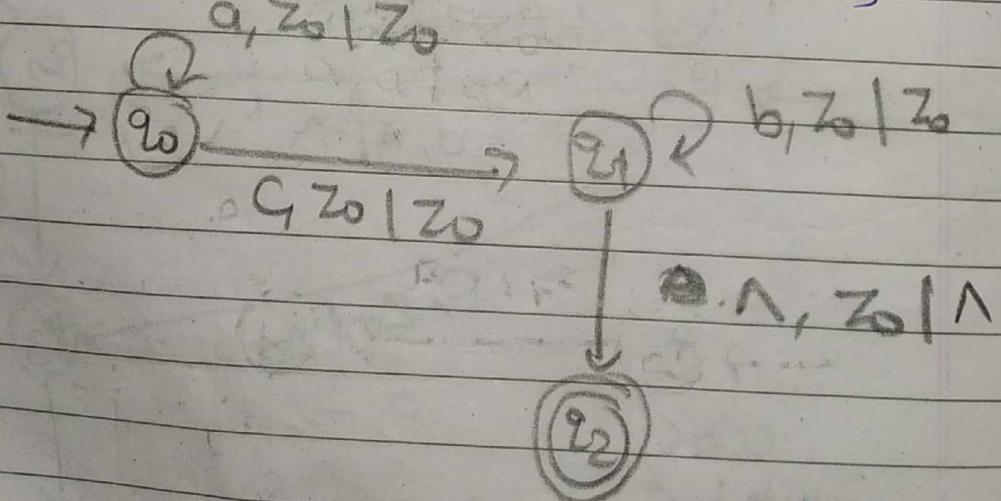


C

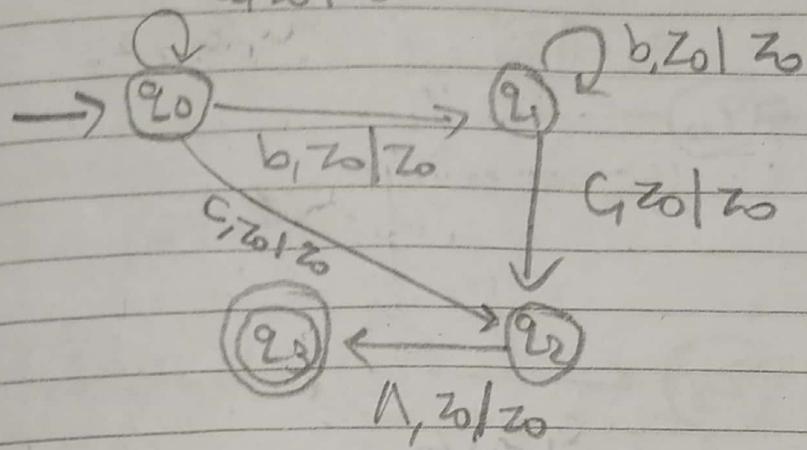
$Ca b$

$Ca a b b$

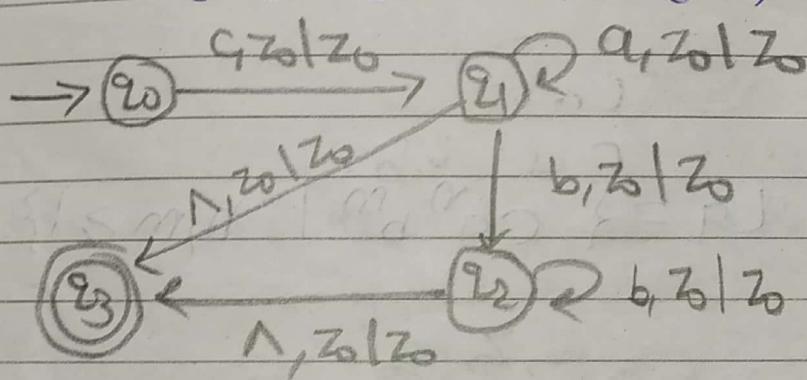
④ $L_4 = \{ a^n c b^m \mid n, m \geq 0 \}$



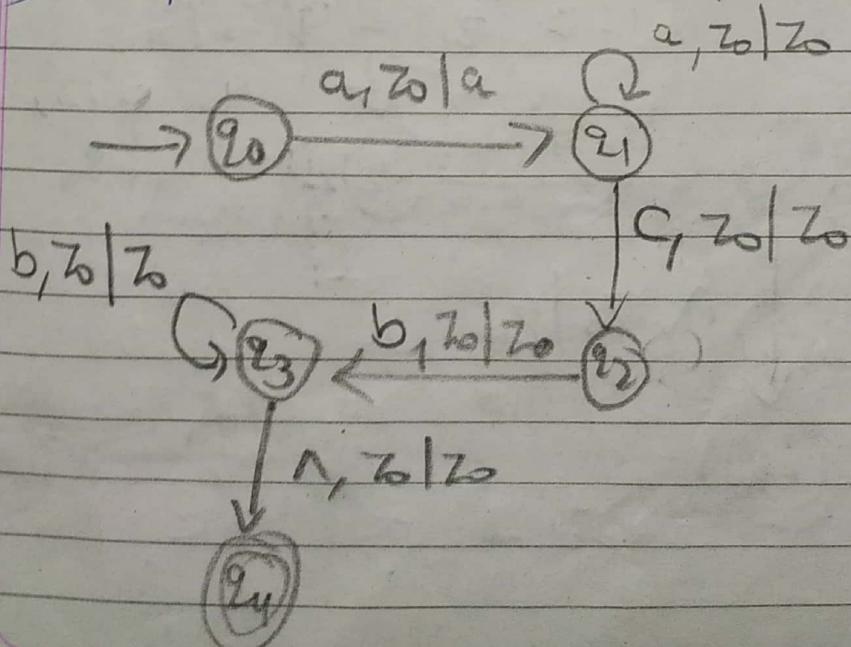
$$⑤ L_5 = \{ a^n b^m c \mid n, m \geq 0 \}$$



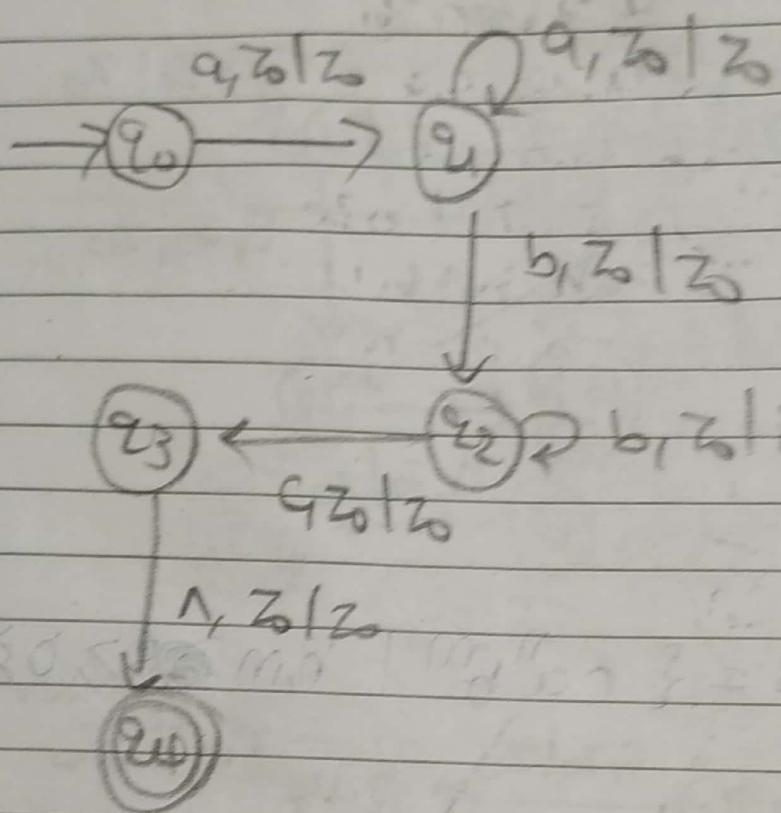
$$⑥ L_6 = \{ c a^n b^m \mid n, m \geq 0 \}$$



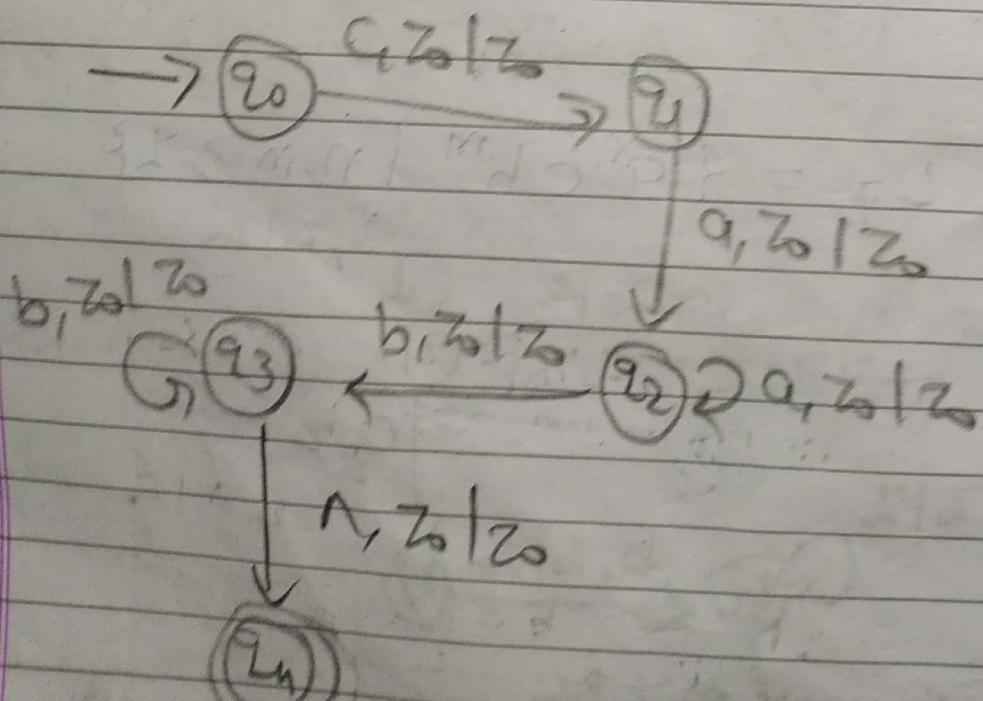
$$⑦ L_7 = \{ a^n c b^m \mid n, m \geq 1 \}$$



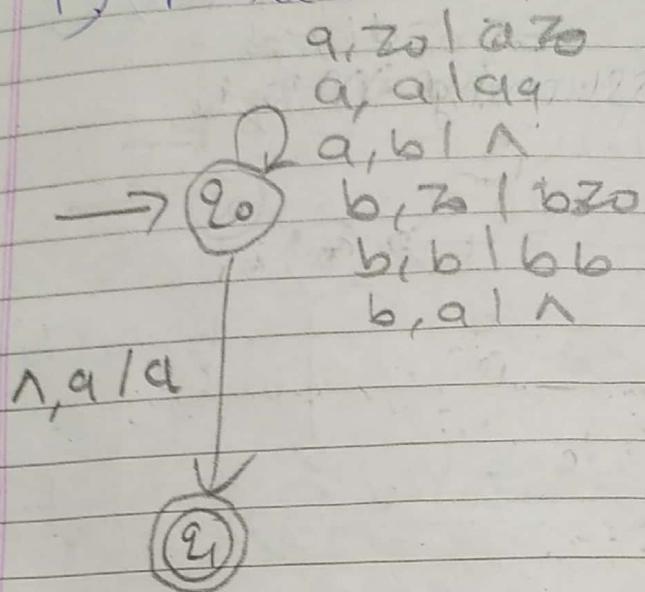
8) $L_8 = \{a^n b^m c \mid n, m \geq 1\}$



9) $L_9 = \{ a^n b^m \mid n, m \geq 1\}$



i) More no. of a's than b's



\Rightarrow More generic

Example

a	✓
ab	✗
aab	✓
abab	✗
abaaabbba	✓

ii) $L = \{ a^n b^{2n} \mid n \geq 1 \}$

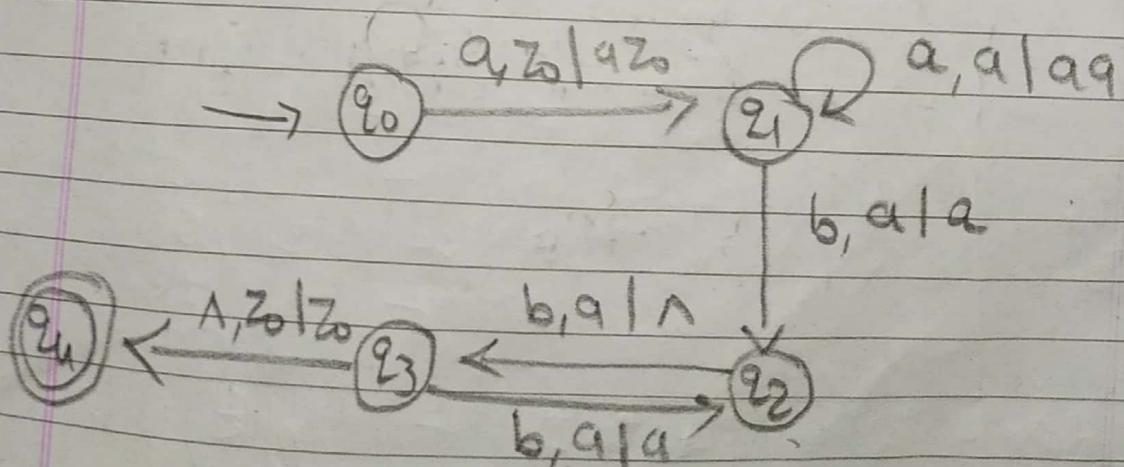
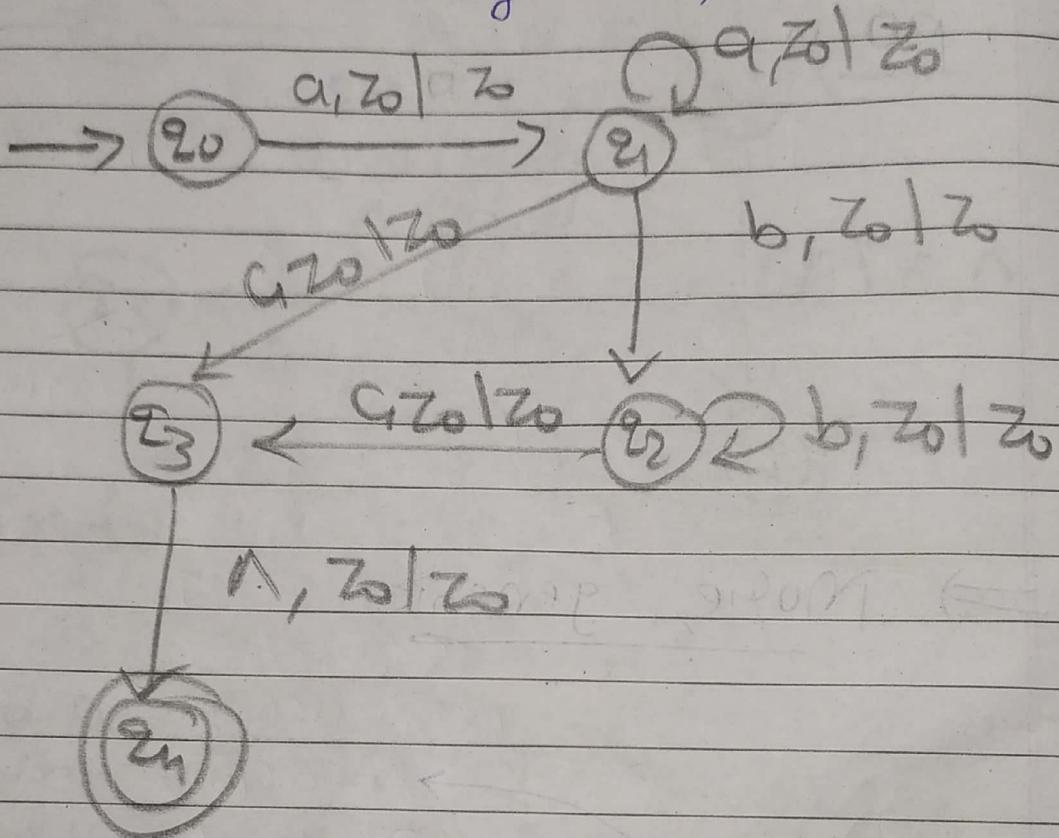
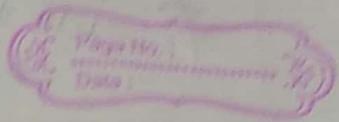


abb	aabbba	✓
ab	aab	X
	aaabbba	X

12) $L = \{ a^n b^m c_1 \mid n \geq 1 \}$

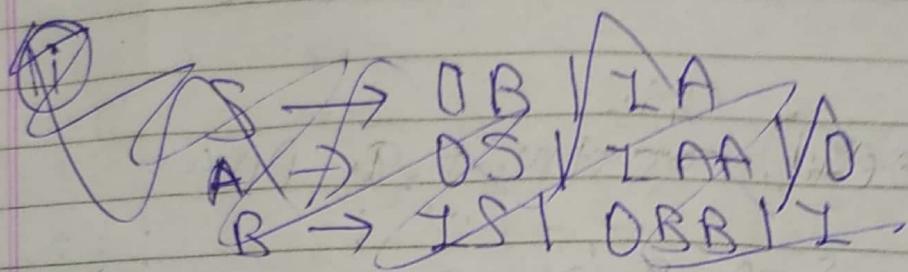
assuming $m > 0$.





(2)

PDA for given CFG



Theory

CFG to PDA

- Initially start symbol is pushed to the stack.
- The transitions are added as

$$\delta(q, \epsilon, A) = \{ (q, \alpha) \mid A \rightarrow \alpha \text{ is in } P \}$$

$$\delta(q, t, t) = \{ (q, \epsilon) \mid \text{for every } t \text{ in } T \}$$

A is Non terminal,
t is terminal

i

$$\begin{aligned} S &\rightarrow DB \mid IA \\ A &\rightarrow OS \mid IAA \mid O \\ B &\rightarrow IS \mid OBB \mid I \end{aligned}$$

→ we'll construct a PDA

$$\{Q, \Sigma, \Gamma, \delta, q_0, z_0, F\}$$

where,

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

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

$$\Gamma = \{S, B, O, I, z_0\}$$

~~is transition function~~ δ is transition function

~~defined as table~~

~~table~~

$$F = \{q_2\}$$

or you can write like this

Rule	State	Input	Stack Symbol	Move (S)
1	q_0	λ	$S z_0$	(q_1, Sz_0)
2	q_{01}	λ	S	$(q_1, DB), (q_1, TA)$
3	q_{01}	λ	A	$(q_1, OS), (q_1, YAA), (q_1, O)$
4	q_{01}	λ	B	$(q_1, IS), (q_1, DBB), (q_1, I)$
5	q_1	λ 0	0	(q_1, N)
6	q_1	1	1	(q_1, N)
7	q_1	λ	z_0	(q_2, z_0)

1 CTB method [Page no- 269]

⇒ Tracing for 0001101110

used Rule	Left-most derivation
	($q_0, 0001101110, z_0$)
1	$\vdash (q_1, 0001101110, Sz_0) \quad S$
2(i)	$\vdash (q_1, 0001101110, DBz_0) \Rightarrow DB$
3S	$\vdash (q_1, 001101110, Bz_0)$
4(ii)	$\vdash (q_1, 001101110, BBBz_0) \Rightarrow 00BB$
5	$\vdash (q_1, 01101110, BBBBz_0)$
4(ii)	$\vdash (q_1, 01101110, BBBBz_0) \Rightarrow 000DBBB$
5	$\vdash (q_1, 1101110, BBBBz_0)$
4(iii)	$\vdash (q_1, 1101110, BBBBz_0) \Rightarrow 0001BBB$
6	$\vdash (q_1, 101110, BBBBz_0)$
4(iii)	$\vdash (q_1, 101110, BBBBz_0) \Rightarrow 00011BB$
5	$\vdash (q_1, 01110, BBBBz_0)$

~~SATIN~~

used rule / Transition

4(iii)	$\vdash (q_1, 01110, 0BBz_0)$	$\Rightarrow 000110BB$
5	$\vdash (q_1, 1110, BBz_0)$	
4(iii)	$\vdash (q_1, 1110, 1Bz_0)$	$\Rightarrow 0001101B$
6	$\vdash (q_1, 110, Bz_0)$	
4(i)	$\vdash (q_1, 110, 1Sz_0)$	$\Rightarrow 0001101S$
6	$\vdash (q_1, 10, Sz_0)$	
2 (ii)	$\vdash (q_1, 10, 1Az_0)$	$\Rightarrow 00011011ZA$
6	$\vdash (q_1, 0, AZ_0)$	
3(iii)	$\vdash (q_1, 0, 0z_0)$	$\Rightarrow 00011001110$
5	$\vdash (q_1, \wedge, z_0)$	
7	$\vdash (q_2, \wedge, z_0)$	

Accepted

2

$$S \rightarrow b|bs|ass|ssq|sas$$

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

$$\Omega = \{a, b\}$$

$$\Sigma = \{a, b, \$, z_0\}$$

$$F = \{i_2\}$$

8 is as shown in table

State	Input	Stack symbol	moves
q_0	λ	z_0	$(q_1, S z_0)$
q_1	λ	S	$(q_1, b) (q_1, b),$ $(q_1, a S) (q_1, S a)$
q_1	a	a	$(q_1, a S)$
q_1	b	b	(q_1, λ)
q_2	λ	z_0	(q_2, λ)

1013101 3

PDA, for CFG

$$S \rightarrow XSX\bar{Y}$$

$$x \rightarrow 0^+ \text{ (0.01010101...)} \rightarrow$$

$\rightarrow 021|720$

$$z \rightarrow xzx^{\dagger}x$$

$$Q = \{q_0, q_1, q_2\} \quad . \quad (35)$$

$$\Omega = \{0, 1, 2\}^n = \{(0, 0, 0), (1, 1, 1), \dots, (2, 2, 2)\}$$

$$N = \{0, 1, 5, X, Y, Z, Z_0\}$$

$$F = \{q_2\} \times \{x, y, z\} \cup \{p\} \rightarrow \{q_1\} \quad (17)$$

δ is transition function as follow (58)

Time	State	Input	Stack Symbol	move(s)
initials			(0)	
1	q0	A	Z0	(q1, 5Z0)
2	q1	A	(05) / 010	(q1, X5X), (q1, Y)
3	q1	A	(05) / X0 / 010	(q1, 0), (q1, 1)
4	q1	A	(05) / 010 / Y1 / 010	(q1, 0Z1), (q1, 1Z0)
5	q1	A	(05) / Z0 / 010	(q1, XZX), (q1, X)
XIXX5X			(05) / X5X / 101010	
6	q1	O	0 / 1XX5 00 / 010	(q1, A) - (i)2
7	q1	O	15 / XX5 00 / 010	(q1, A) - F
XIXX5X / 010			(05) / X5X / 101010	
8	q1	A	XX5 Z0 / 010	(q2, Z0) - (i)2
XIXX5X / 010			(05) / XX5 101010	
9	q2	A	Z0 / 010	(q2, A) - (i)2
XIXX5X / 010			(05) / XX5 101010	
10	q2	A	Z0 / 010	(q2, A) - F
XIXX5X / 010			(05) / XXXX 101010	
11	q2	A	XXX 010	(q2, A) - (i)2
XIXX5X / 010			(05) / XXXX 101010	
12	q2	A	010	(q2, A) - F
XIXX5X / 010			(05) / XXXX 101010	

\Rightarrow tracing for 01010101

Rule used

($z_0, 01010101, z_0$)

1	$\vdash (q_1, 01010101, Sz_0)$
2(i)	$\vdash (q_1, 01010101, XSXz_0)$
3(i)	$\vdash (q_1, 01010101, OSXz_0)$
6	$\vdash (q_1, 1010101, SXz_0)$
2(ii)	$\vdash (q_1, 1010101, XSXXz_0)$
3(ii)	$\vdash (q_1, 1010101, LSXXz_0)$
7	$\vdash (q_1, 010101, SXXz_0)$
2(i)	$\vdash (q_1, 010101, XSXXXz_0)$
3(i)	$\vdash (q_1, 010101, OSXXXz_0)$
	$\vdash (q_1, 010101, SXXXz_0)$

Rule used

($z_0, 01010101, z_0$)

left most derivation

1	$\vdash (q_1, 01010101, Sz_0)$	S
2(ii)	$\vdash (q_1, 01010101, Yz_0)$	$\Rightarrow Y$
3(i)	$\vdash (q_1, 01010101, OZ1z_0)$	$\Rightarrow OZ1$
6	$\vdash (q_1, 01010101, Z1z_0)$	Z
5(i)	$\vdash (q_1, 01010101, XZX1z_0)$	$\Rightarrow OXZX1$
3(ii)	$\vdash (q_1, 01010101, LZXX1z_0)$	$\Rightarrow O1ZX1$
7	$\vdash (q_1, 01010101, ZX1z_0)$	Z
5(i)	$\vdash (q_1, 01010101, XZX1z_0)$	$\Rightarrow O1XZX1$
3(i)	$\vdash (q_1, 01010101, OZX1z_0)$	$\Rightarrow O1OZX1$
6	$\vdash (q_1, 01010101, ZX1z_0)$	Z
5(i)	$\vdash (q_1, 01010101, XZX1z_0)$	$\Rightarrow O1OZX1$
3(ii)	$\vdash (q_1, 01010101, LZXX1z_0)$	$\Rightarrow O1O1ZX1$
7	$\vdash (q_1, 01010101, ZX1z_0)$	Z
5(ii)	$\vdash (q_1, 01010101, XXX1z_0)$	$\Rightarrow O1O1XXXX1$

3(i)	$\vdash (q_1, 0101, 0XXX z_0) \Rightarrow 01010XXX\perp$
6	$\vdash (q_1, 101, XXX z_0) \Rightarrow 010101XX\perp$
3(ii)	$\vdash (q_1, 101, 1XX z_0) \Rightarrow 010101XX\perp$
7	$\vdash (q_1, 01, XX z_0) \Rightarrow 0101010X\perp$
3(i)	$\vdash (q_1, 01, 0X z_0) \Rightarrow 0101010X\perp$
6	$\vdash (q_1, 1, 1X z_0) \Rightarrow 01010101\perp$
3(ii)	$\vdash (q_1, 1, 11 z_0) \Rightarrow 01010101\perp$
7	$\vdash (q_1, \lambda, z_0) \Rightarrow 01010101\perp$

Σ NOT accepted

$$f(\varnothing, \varnothing, \varnothing, \varnothing) = \varnothing$$

$$\{ \varnothing, \varnothing \} = \varnothing$$

$$f(\varnothing, \varnothing, f) = f$$

$$f = \varnothing$$

$$\varnothing^\Sigma = \Sigma$$

$$\begin{aligned} & [P P_0 P] [P P_0 P], [P P_0 P] [P] = V \\ & [P_0 P_0 P] [P_0 P_0 P], [P_0 P_0 P] \\ & [P_0 P_0 P], [P_0 P_0 P], [P_0 P_0 P] \\ & [P_0 P_0 P] [P_0 P_0 P], [P_0 P_0 P] \\ & [P_0 P_0 P] [P_0 P_0 P], [P_0 P_0 P] \\ & [P_0 P_0 P] [P_0 P_0 P], [P_0 P_0 P] \end{aligned}$$

$$\begin{aligned} & [P_0 P_0 P] \leftarrow 2 \quad \leftarrow \\ & [P_0 P_0 P] \leftarrow 2 \\ & [P_0 P_0 P] \leftarrow 2 \end{aligned}$$

3

PDA to CFG

①

$$\begin{aligned}\delta(q_0, a, z_0) &\vdash (q_0, a z_0) \\ \delta(q_0, a, a) &\vdash (q_0, a a) \\ \delta(q_0, a, a) &\vdash (q_1, a) \\ \delta(q_1, a, a) &\vdash (q_2, \epsilon) \\ \delta(q_2, a, a) &\vdash (q_2, \epsilon) \\ \delta(q_2, \epsilon, z_0) &\vdash (q_2, \epsilon)\end{aligned}$$

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

$$\Sigma = \{a, c\}$$

$$N = \{a, z_0\}$$

$$q_0 = q_0$$

$$z_0 = z_0$$

$$V = \{S, [q_0 a z_0], [q_0 a q_1], [q_0 a q_2], [q_0 z_0 z_0], [q_0 z_0 q_1], [q_0 z_0 q_2], [q_1 a z_0], [q_1 a q_1], [q_1 a q_2], [q_1 z_0 z_0], [q_1 z_0 q_1], [q_1 z_0 q_2], [q_2 a z_0], [q_2 a q_1], [q_2 a q_2], [q_2 z_0 z_0], [q_2 z_0 q_1], [q_2 z_0 q_2]\}$$

→ S production:

$$P_1: S \rightarrow [q_0 z_0 z_0]$$

$$P_2: S \rightarrow [q_0 z_0 q_1]$$

$$P_3: S \rightarrow [q_0 z_0 q_2]$$

Productions for transition!

$$\Rightarrow \delta(q_0, a, z_0) \vdash (q_0, a z_0)$$

$$P_4: [q_0 z_0 z_0] \rightarrow a [q_0 q_0 z_0] [z_0 z_0 z_0]$$

$$P_5: [q_0 z_0 z_0] \rightarrow a [q_0 a z_0] [q_0 z_0 z_0]$$

$$P_6: [q_0 z_0 z_0] \rightarrow a [q_0 q_2 z_0] [q_2 z_0 z_0]$$

$$P_7: [q_0 z_0 q_1] \rightarrow a [q_0 q_0 z_0] [q_0 z_0 q_1]$$

$$P_8: [q_0 z_0 q_1] \rightarrow a [q_0 q_1 z_0] [q_1 z_0 q_1]$$

$$P_9: [q_0 z_0 q_1] \rightarrow a [q_0 q_1 q_1] [q_1 z_0 q_1]$$

$$P_{10}: [q_0 z_0 q_1] \rightarrow a [q_0 a q_0] [q_0 z_0 q_2]$$

$$P_{11}: [q_0 z_0 q_2] \rightarrow a [q_0 q_1 q_1] [q_1 z_0 q_2]$$

$$P_{12}: [q_0 z_0 q_2] \rightarrow a [q_0 a q_1] [q_1 z_0 q_2]$$

$$\Rightarrow \delta(q_0, a, a) \vdash (q_0, aa)$$

$$P_{13}: [q_0 a q_0] \rightarrow a [q_0 a q_0] [q_0 a q_0]$$

$$P_{14}: [q_0 a q_0] \rightarrow a [q_0 a q_1] [q_1 a q_0]$$

$$P_{15}: [q_0 a q_0] \rightarrow a [q_0 a q_2] [q_2 a q_0]$$

$$P_{16}: [q_0 a q_1] \rightarrow a [q_0 a q_0] [q_0 a q_1]$$

$$P_{17}: [q_0 a q_1] \rightarrow a [q_0 a q_1] [q_1 a q_1]$$

$$P_{18}: [q_0 a q_1] \rightarrow a [q_0 a q_2] [q_2 a q_1]$$

$$P_{19}: [q_0 a q_2] \rightarrow a [q_0 a q_0] [q_0 a q_2]$$

$$P_{20}: [q_0 a q_2] \rightarrow a [q_0 a q_1] [q_1 a q_2]$$

$$P_{21}: [q_0 a q_2] \rightarrow a [q_0 a q_2] [q_2 a q_2]$$

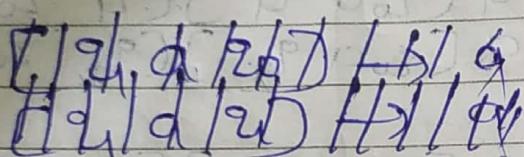
$\Rightarrow \delta(z_0, q_0) \vdash (q_1, a)$

$$P_{21}: [z_0, a z_0] \rightarrow c[z_1, a z_0]$$

$$P_{22}: [z_0, a q_1] \rightarrow c[q_1, a z_0]$$

$$P_{23}: [z_0, a z_1] \rightarrow c[q_1, a z_1]$$

$\Rightarrow \delta(q_1, a, a) \vdash (q_2, \epsilon)$



$$P_{24}: [q_1, a z_1] \rightarrow q_2 \leftarrow (\cancel{a} z_1)$$

$\Rightarrow \delta(q_2, a, a) \vdash (q_2, \epsilon)$

$$P_{25}: [q_2, a z_2] \rightarrow q_2 \leftarrow (\cancel{a} z_2)$$

$\Rightarrow \delta(q_2, \epsilon, z_0) \rightarrow (q_2, \epsilon)$

$$P_{26}: [q_2, z_0 z_2] \rightarrow \epsilon \leftarrow (\cancel{z_0} z_2)$$

Optional Part

Now, give name to these variables

$[z_0 q_1 q_0]$	A	$[q_1 q_0 z_0]$	G	$[z_0 q_0 z_0]$	M
$[z_0 q_1 q_1]$	B	$[q_1 q_1 z_0]$	H	$[z_0 q_1 z_0]$	N
$[z_0 q_1 q_2]$	C	$[q_1 q_2 z_0]$	I	$[z_0 q_2 z_0]$	O
$[z_0 z_0 z_0]$	D	$[q_1 z_0 z_0]$	J	$[z_0 z_0 z_0]$	P
$[z_0 z_0 q_1]$	E	$[q_1 z_0 q_1]$	K	$[z_0 z_0 q_1]$	Q
$[z_0 z_0 q_2]$	F	$[q_1 z_0 q_2]$	L	$[z_0 z_0 q_2]$	R

$S \rightarrow D | E | F$
 $D \rightarrow aAD | aB | aC | aP$

$E \rightarrow aAE | aBK | aCQ$
 $F \rightarrow aAF | aBL | aCR$
 $A \rightarrow aAA | aBG | aCM | aGT$
 $B \rightarrow aAB | aBH | aCN | aCH$

$J \rightarrow -$
 $C \rightarrow aAC | aBI | aCO | aCI$

$P \rightarrow -$

$K \rightarrow -$

$Q \rightarrow -$

$L \rightarrow -$

$R \rightarrow \Sigma$

$G \rightarrow -$

$M \rightarrow -$

$H \rightarrow -$

$N \rightarrow -$

$I \rightarrow a$

$O \rightarrow a.$

Answer

Final

Answer I am not sure
 which part of this solution is optional.

As soon as, Ma'am will send example on
 this topic , I'll update this.

[2]

$$\begin{aligned}\delta(q_0, I, z_0) &\vdash (q_0, Kz_0) \\ \delta(q_0, \varepsilon, z_0) &\vdash (q_0, \varepsilon) \\ \delta(q_0, I, K) &\vdash (q_0, KK) \\ \delta(q_0, 0, K) &\vdash (q_1, K) \\ \delta(q_1, 0, K) &\vdash (q_1, \varepsilon) \\ \delta(q_0, 0, z_0) &\vdash (q_0, z_0)\end{aligned}$$

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

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

$$N = \{K, z_0\}$$

$$q = q_0$$

$$z = z_0$$

$$V = \{ V, [q_0 K q_0] [q_0 K q_1] [q_0 z_0 z_0] [q_0 z_0 q_1] \\ [q_1 K q_0] [q_1 K q_1] [q_1 z_0 z_0] [q_1 z_0 q_1] \}$$

\Rightarrow S productions.

$$P_1: S \rightarrow [q_0 z_0 z_0]$$

$$P_2: S \rightarrow [q_0 z_0 q_1]$$

\Rightarrow productions for transition $\delta(q_0, I, z_0) \vdash (q_0, Kz_0)$

$$P_3: [q_0 z_0 z_0] \rightarrow I [q_0 K q_0] [q_0 z_0 z_0]$$

$$P_4: [q_0 z_0 z_0] \rightarrow I [q_0 K q_1] [q_0 z_0 z_0]$$

$$P_5: [q_0 z_0 q_1] \rightarrow I [q_0 K q_0] [q_0 z_0 q_1]$$

$$P_6: [q_0 z_0 q_1] \rightarrow I [q_0 K q_1] [q_1 z_0 q_1]$$

\Rightarrow productions for $\delta(z_0, \varepsilon, z_0) \vdash (z_0, \varepsilon)$

$P_7: [z_0 z_0 z_0] \xrightarrow{\cdot} \varepsilon$

\Rightarrow productions for $\delta(z_0, z_1, K) \vdash (z_0, KK)$

$P_8: [z_0 K z_0] \xrightarrow{\cdot} [z_0 K z_0] [z_0 K z_0]$

$P_9: [z_0 K z_0] \xrightarrow{\cdot} [z_0 K z_1] [z_0 K z_0]$

$P_{10}: [z_0 K z_1] \xrightarrow{\cdot} [z_0 K z_0] [z_0 K z_1]$

$P_{11}: [z_0 K z_1] \xrightarrow{\cdot} [z_0 K z_1] [z_1 K z_1]$

\Rightarrow productions for $\delta(z_0, 0, K) \vdash (z_1, K)$

$P_{12}: [z_0 K z_0] \xrightarrow{0} [z_1 K z_0]$

$P_{13}: [z_0 K z_1] \xrightarrow{0} [z_1 K z_1]$

\Rightarrow productions for $(\delta(z_1, 0, K) \vdash (z_1, K))$

$P_{14}: [z_1 K z_1] \xrightarrow{0}$

\Rightarrow productions for $\delta(z_1, 0, z_0) \vdash (z_0, z_0)$

$P_{15}: [z_1 z_0 z_0] \xrightarrow{0} [z_0 z_0 z_0]$

$P_{16}: [z_1 z_0 z_1] \xrightarrow{0} [z_0 z_0 z_1]$

Done

Table is given in question

$$V \cup Q = \{ z_0, z_1 \}$$

$$\Sigma = \{ a, b, c \}$$

$$N = \{ A, B, Z_0 \}$$

$$z_0 = \{ w \}$$

$$z_1 = \{ z_0 \}$$

\Rightarrow CFG

$$V = \{ S, [z_0 A z_0] [z_0 A z_1] [z_0 B z_0]$$

$$[z_0 B z_0] [z_0 B z_1] [z_0 z_0 z_0] [z_0 z_0 z_1]$$

$$[z_1 A z_0] [z_1 A z_1] [z_1 B z_0] [z_1 B z_1]$$

$$[z_1 z_0 z_0] [z_1 z_0 z_1] \}$$

\rightarrow S productions:

$$P_1: S \rightarrow [z_0 z_0 z_0]$$

$$P_2: S \rightarrow [z_0 z_0 z_1]$$

\rightarrow productions for $\delta(z_0, a, z_0) \vdash (z_0, A z_0)$

$$P_3: [z_0 z_0 z_0] \rightarrow a [z_0 A z_0] [z_0 z_0 z_0]$$

$$P_4: [z_0 z_0 z_0] \rightarrow a [z_0 A z_1] [z_0 z_0 z_0]$$

$$P_5: [z_0 z_0 z_1] \rightarrow a [z_0 A z_0] [z_0 z_0 z_1]$$

$$P_6: [z_0 z_0 z_1] \rightarrow a [z_0 A z_1] [z_0 z_0 z_1]$$

→ productions for $\delta(q_0, b, z_0) \vdash (q_0, Bz_0)$

$$P_7: [q_0 z_0 z_0] \rightarrow b [q_0 B z_0] [q_0 z_0 z_0]$$

$$P_8: [q_0 z_0 z_0] \rightarrow b [q_0 B \frac{z_0}{4}] [q_4 z_0 z_0]$$

$$P_9: [q_0 z_0 z_4] \rightarrow b [q_0 B z_0] [q_0 z_0 z_4]$$

$$P_{10}: [q_0 z_0 z_4] \rightarrow b [q_0 B \frac{z_4}{4}] [q_4 z_0 z_4]$$

→ productions for $\delta(q_0, q; A) \nvdash (q_0, AA)$

$$P_{11}: [q_0 A q_0] \rightarrow q [q_0 A z_0] [q_0 A z_0]$$

$$P_{12}: [q_0 A z_0] \rightarrow q [q_0 A \frac{z_0}{4}] [q_4 A z_0]$$

$$P_{13}: [q_0 A z_1] \rightarrow q [q_0 A z_0] [q_0 A z_1]$$

$$P_{14}: [q_0 A z_1] \rightarrow q [q_0 A \frac{z_1}{4}] [q_4 A z_1]$$

→ productions for $\delta(q_0, b; A) \vdash (q_0, BA)$

$$P_{15}: [q_0 A z_0] \rightarrow b [q_0 B z_0] [q_0 A z_0]$$

$$P_{16}: [q_0 A z_0] \rightarrow b [q_0 B \frac{z_0}{4}] [q_4 A z_0]$$

$$P_{17}: [q_0 A \frac{z_0}{4}] \rightarrow b [q_0 B z_0] [q_0 A \frac{z_0}{4}]$$

$$P_{18}: [q_0 A \frac{z_0}{4}] \rightarrow b [q_0 B \frac{z_0}{4}] [q_4 A \frac{z_0}{4}]$$

→ productions for $\delta(q_0, q; B) \vdash (q_0, AB)$

$$P_{19}: [q_0 B z_0] \rightarrow q [q_0 A z_0] [q_0 B z_0]$$

$$P_{20}: [q_0 B z_0] \rightarrow q [q_0 A \frac{z_0}{4}] [q_4 B z_0]$$

$$P_{21}: [q_0 B z_4] \rightarrow q [q_0 A z_0] [q_0 B z_4]$$

$$P_{22}: [q_0 B z_4] \rightarrow q [q_0 A \frac{z_4}{4}] [q_4 B z_4]$$

→ productions for $\delta(q_0, b, B) \vdash (q_0, BB)$

$$P_{23}: [q_0 B q_0] \rightarrow b [q_0 B q_0] [q_0 B q_0]$$

$$P_{24}: [q_0 B q_0] \rightarrow b [q_0 B q_1] [q_1 B q_0]$$

$$P_{25}: [q_0 B q_1] \rightarrow b [q_0 B q_0] [q_0 B q_1]$$

$$P_{26}: [q_0 B q_1] \rightarrow b [q_0 B q_1] [q_1 B q_1]$$

→ productions for $\delta(q_0, c, z_0) \vdash (q_1, z_0)$

$$P_{27}: [q_0 z_0 q_0] \rightarrow c [q_1 z_0 q_0]$$

$$P_{28}: [q_0 z_0 q_1] \rightarrow c [q_1 z_0 q_1]$$

→ productions for $\delta(q_0, c, A) \vdash (q_1, A)$

$$P_{29}: [q_0 A q_0] \rightarrow c [q_1 A q_0]$$

$$P_{30}: [q_0 A q_1] \rightarrow c [q_1 A q_1]$$

→ productions for $\delta(q_0, c, B) \vdash (q_1, B)$

$$P_{31}: [q_0 B q_0] \xrightarrow{c} [q_1 B q_0]$$

$$P_{32}: [q_0 B q_1] \xrightarrow{c} [q_1 B q_1]$$

→ productions for $\delta(q_1, a, A) \vdash (q_1, A)$

$$P_{33}: [q_1 A q_1] \rightarrow \cancel{a}$$

~~P34~~

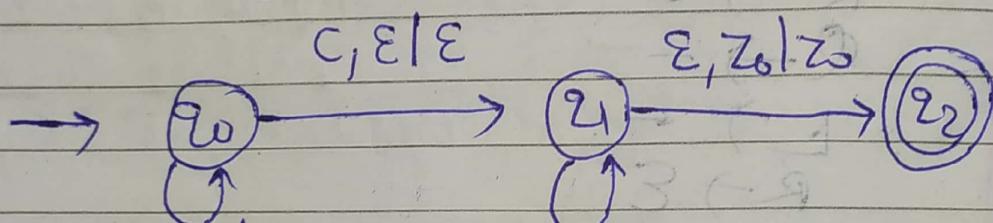
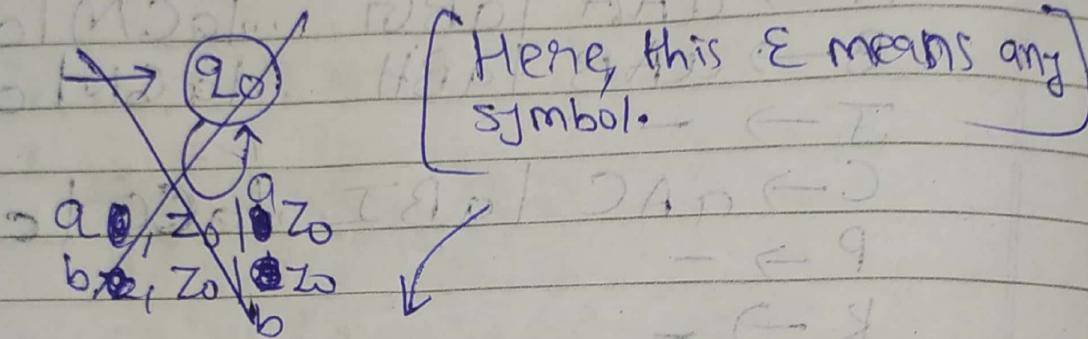
→ productions for $\delta(q_1, b, B) \vdash (q_1, B)$

$$P_{34}: [q_1 B q_1] \rightarrow b$$

→ productions for $\delta(q_1, \gamma, z_0) \vdash (q_1, \gamma)$

$$P_{35}: [q_1 z_0 q_1] \rightarrow \gamma$$

PDA for odd Length



a, zo lato

b₁z₀ | b₂z₀

a, a laq

a, b | ab

b, b | bb

b, a l bb

Worrell

a a i e

b | ε

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DPDA

-Training for abcba

$(z_0, abcba, z_0)$

5 / ((20, abcba, S), 20)

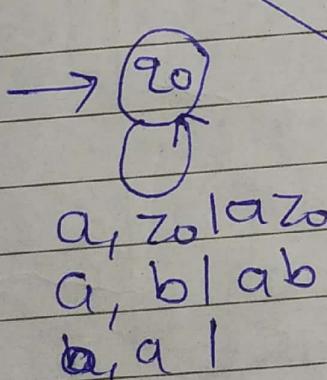
$F'(z_0; abcb)$

Input
Symbol

	Current State	String	Next State	Stack	Push	Pop
-	q0	abcba'ε	-	Z03	-	-
a	q0	bcb'a'ε	q0	Z0'a	a	-
b	q0	cba'ε	q0	Z0 a b	b	-
c	q0	ba'ε	q1	Z0, a b	-	-
b	q1	a'ε	q1	Z0 a D	-	b
a	q1	ε	q1	d' Z0, D	-	a
z	q1		q2	p d Z0, d	A -	-
				d d d, d		

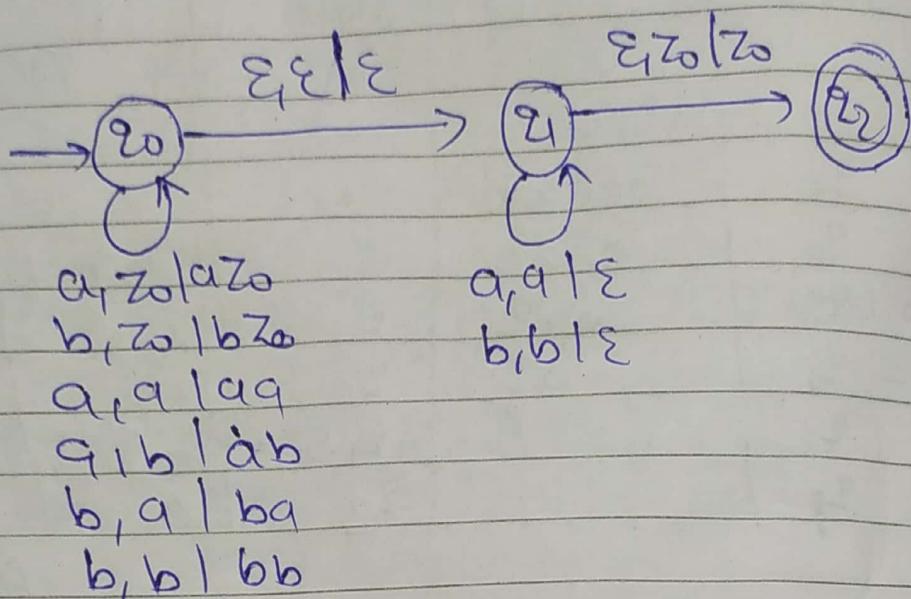
Accepted

PDA for even length



NPDA

PDA for even length



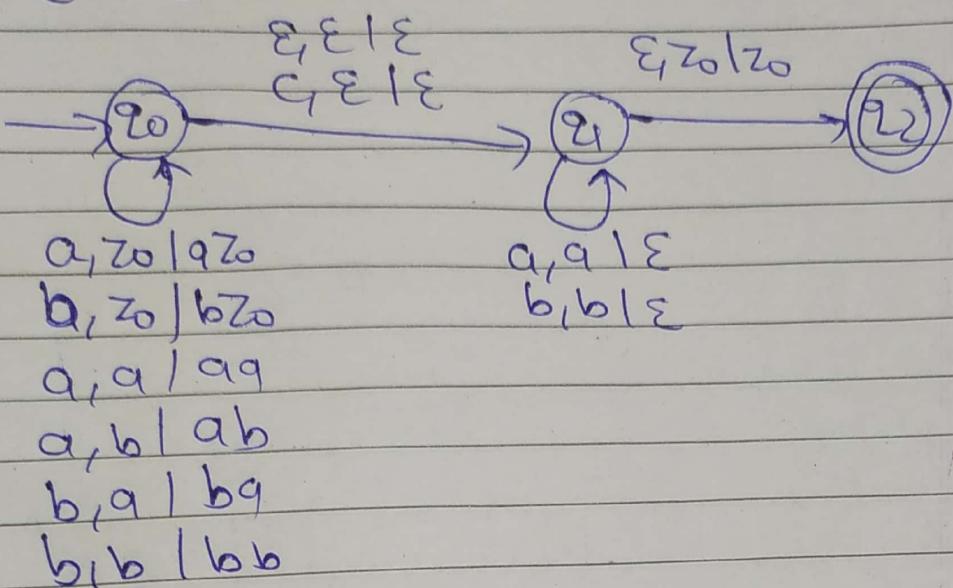
Trace for aabbbaa

aabbbaa | ~~q0 q1 q2 q3 q4 q5 q6~~ | A99

Current State	Remaining String	Input	Next State	Stack	Push	Pop
q_0	aabbbaa ϵ	-	-	z_0	-	-
q_0	abbbaa ϵ	a	q_0	$z_0 a$	-	-
q_0	bbbaa ϵ	a	q_0	$z_0 a b$	b	-
q_0	bbaa ϵ	b	q_0	$z_0 a b b$	b	-
q_0	baa ϵ	ϵ	q_1	$z_0 a b b$	-	-
q_1	aa ϵ	b	q_1	$z_0 a a$	-	b
q_1	a ϵ	a	q_1	$z_0 a$	-	a
q_1	ϵ	a	q_2	z_0	-	a
q_1	ϵ	ϵ	q_2	z_0	-	-

Accepted

All Length Palindromes



For tracing ~~of~~ AT's

- odd length then C will come at half length

& even length then after scanning half length

you have to perform E-move and then
start ~~scanning~~ POP operation.

[And I am not sure in question
what is asked]

- 1) Odd length palindrome
- 2) even length palindrome
- 3) odd and even length both. (all palindrome)

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⇒ This PDA is taking a and b symbol before reading taking c.

After taking ~~c~~ one c symbol
it will take same number of symbols
as it took before c.

$$L = \{ \text{ } \text{ } XcY \mid \text{ } |X| = |Y| \text{ } \} \\ X, Y \in (a, b)^*$$

$|X|$ represent length of X.

ex abc ~~a~~ b [If more 2 Mark and you have time]

Current State	Remaining Symbol	Input	Next State	Stack	Push	Pop
q_0	abc a b E	-	q_0 -	Z_0	-	-
q_0	b c ab E	a	q_0	$Z_0 X$	X	-
q_0	c ab E	b	q_0	$Z_0 XX$	X	-
q_0	c ab E	c	q_1	$Z_0 XX$	X	-
q_1	ab E	c	q_1	Z_0 XX	-	X
q_1	$b E$	a	q_1	$Z_0 X$	-	X
q_1	E	b	q_1	Z_0	-	-
q_2	E	E	q_2	Z_0	Accepted	