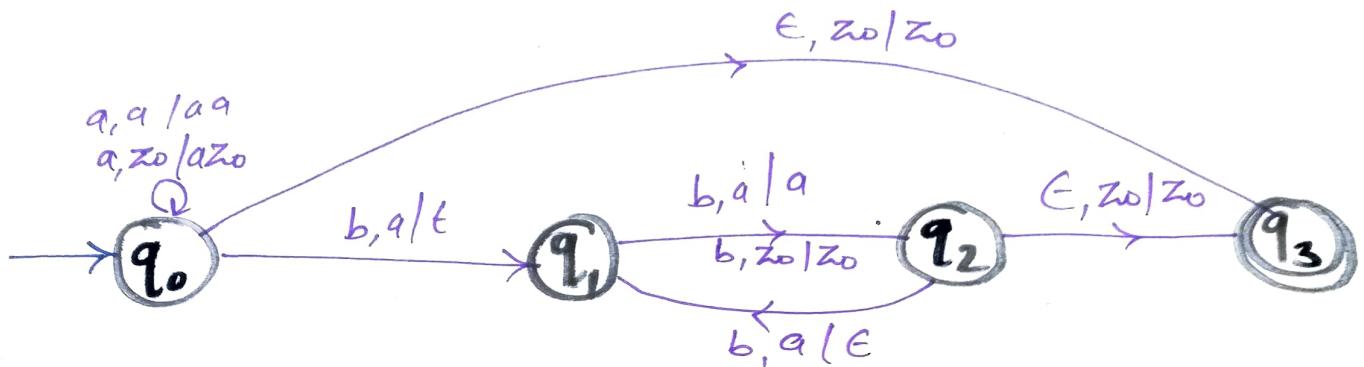
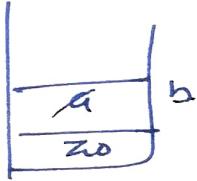


$$4x \quad L = \{ a^m b^n \mid n = 2m \}$$

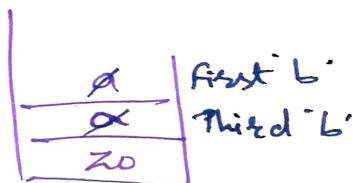
$$\rightarrow L = \left\{ \epsilon, \underline{a} \underline{b} \underline{b}, \underline{a} \underline{a} \underline{b} \underline{b} \underline{b} \underline{b} \dots \right\}$$



$$W = \begin{array}{c} a \ b \ b \\ \downarrow \downarrow \downarrow \\ \text{Push} \ \text{Pop} \ \text{Noop} \end{array}$$



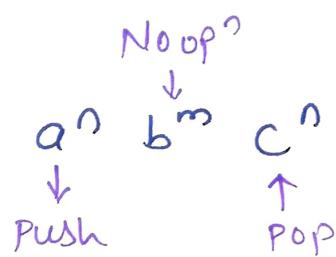
$$W = \begin{array}{c} a \ a \ b \ b \ b \ b \\ \downarrow \downarrow \downarrow \downarrow \\ \text{Push} \ \text{Pop} \ \text{Noop} \ \text{Pop} \end{array} \rightarrow \text{Noopn}$$



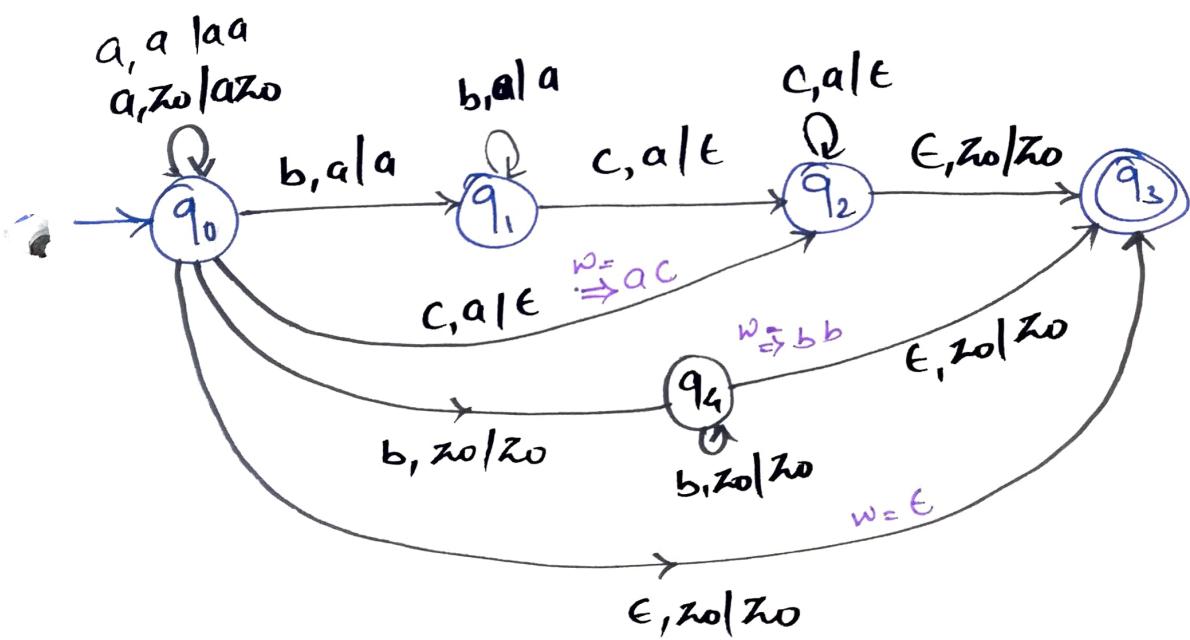
Q. Construct the PDA for the following ~~regular~~ language.

$$\textcircled{1} \quad L = \{a^n b^m c^n \mid m, n \geq 0\} \text{ CFL}$$

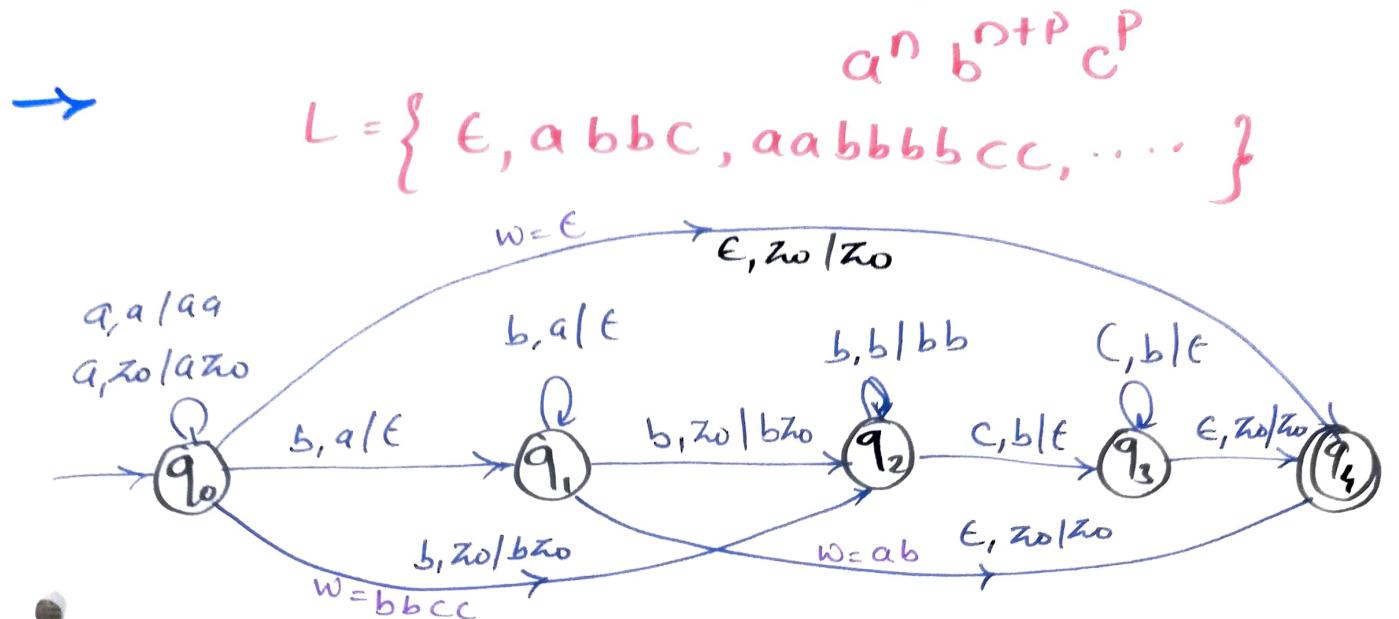
$$\rightarrow L = \{\epsilon, abc, aabbcc, aabccc, aaabbccc, \underline{bb}, \underline{ac}, \dots\}$$



$$\begin{aligned}
 & a^n b^m c^n \Rightarrow m=0 \& n=0 \\
 & , \underline{\epsilon} \\
 & \underline{a \ b \ c} \Rightarrow m=1, n=1 \\
 & . \underline{\frac{ac}{bb}} \Rightarrow m=0, n=1 \\
 & \underline{\frac{ac}{bb}} \Rightarrow m=2, n=0
 \end{aligned}$$



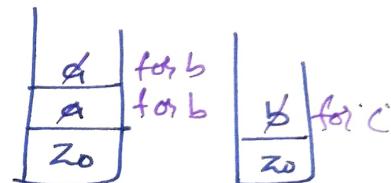
$$\textcircled{2} \quad L = \{ a^n b^m c^p \mid m = n + p \}$$



$$w = \epsilon, \\ q_0 \rightarrow q_4$$

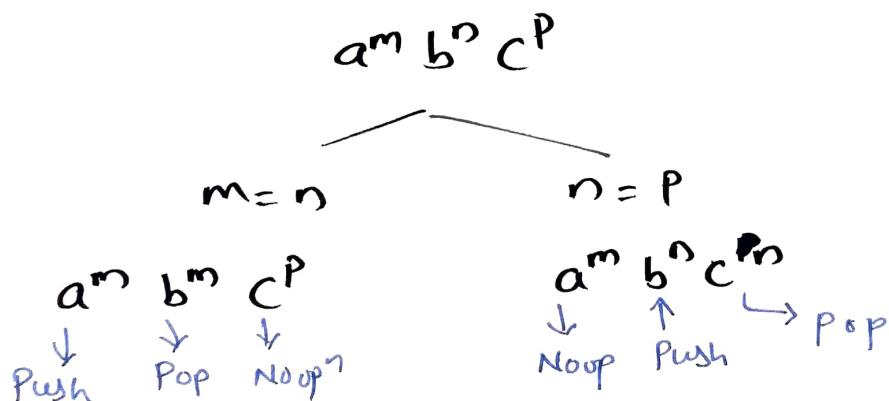
$$w = a^b \epsilon \\ q_0 \rightarrow q_1 \rightarrow q_4$$

$$w = b b c c, w = \underline{a a b b b} c \\ \downarrow \text{push} \quad \downarrow \text{pop} \quad \downarrow \text{push} \quad \downarrow \text{pop} \\ q_0 \rightarrow q_2 \rightarrow q_3 \rightarrow q_4$$

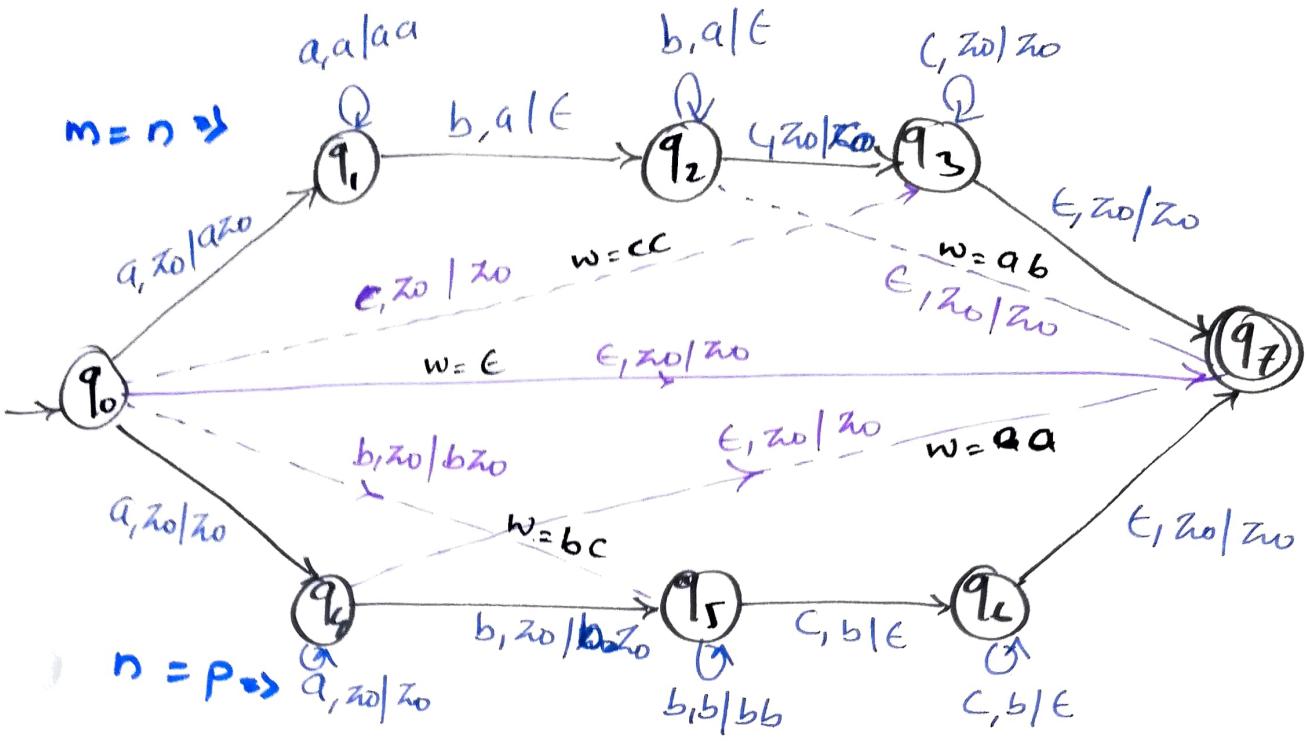


$$\textcircled{3} \quad L = \{ a^m b^n c^p \mid m = n \mid n = p \}$$

\rightarrow



$$\delta(q_0, a, z_0) \xrightarrow{a z_0 \Rightarrow \text{Push}} \xrightarrow{z_0 \Rightarrow \text{No op?}}$$



$$\begin{array}{c}
 a^m b^n c^p \\
 \swarrow \quad \searrow \\
 m=n \quad n=p \\
 a^m b^m c^p \quad a^m b^m c^n
 \end{array}$$

i) $m=0 \Rightarrow c^p \Rightarrow cc \Rightarrow \underline{q_0 \rightarrow q_3}$

ii) $p=0 \Rightarrow a^m b^m \Rightarrow aabb \Rightarrow \underline{q_2 \rightarrow q_7}$

i) $m=0 \Rightarrow a^m \Rightarrow \underline{q_4 \rightarrow q_7}$

ii) $m=0 \Rightarrow b^m c^m \Rightarrow \underline{q_0 \rightarrow q_5}$

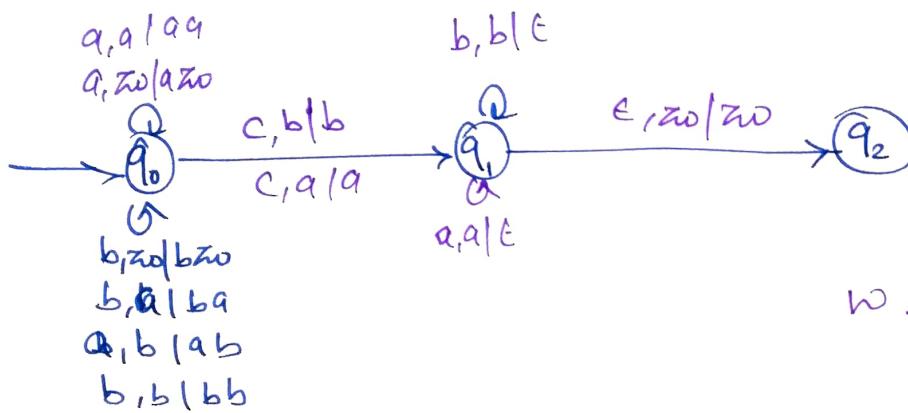
Q Construct PDA for given palindrome.

① $L = \{ w c w^R \mid w \in (a, b)^+ \}$ odd length palindrome.

\Rightarrow $w c w^R$
 Original String \downarrow \rightarrow Reverse String

ab c ba
 abb c bb \textcircled{q}

w c w^R
 Push \Downarrow $\text{No}^n L$ Pop
 ab c ba



w = aabcbaa
 push \uparrow pop \uparrow

w = ab c ba
 Push No Pop

x	for b
a	for a
z0	

w = ba c ab

a	for a
b	for b
z0	

\Rightarrow If we see the center 'c' then don't do anything compare the w with w^R strings.

Q. Construct PDA for given Palindrome.

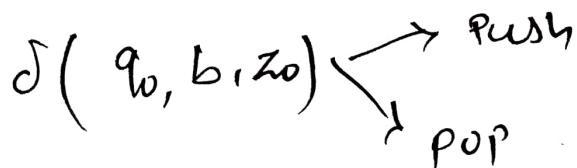
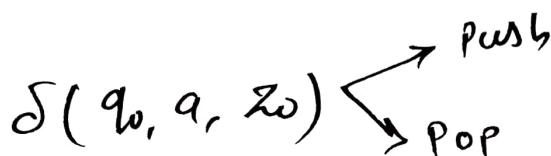
② $L = \{ \underline{ww^R} \mid w \in (a,b)^+ \}$ Set of all evenlength palindrome.

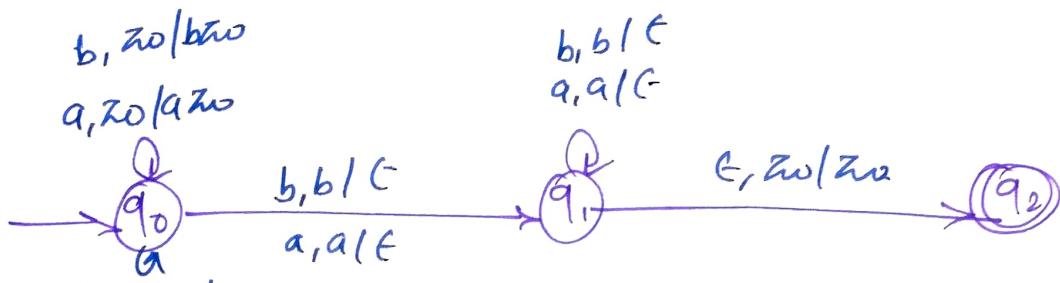
⇒ ① Whenever the top of the stack is same as i/p symbol, then there is chance of center (or) matching

$w = \underline{\underline{aba}}$
w Push wR Pop

② ex:- a|aa So top & i/p symbol is same that doesn't mean there will be centre.

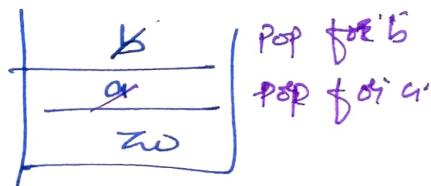
In this case-





$\{a, b\}$ } Center has not
 $\{a, a/a\}$ } come push into stack
 $\{b, b/b\}$ }

$w = \overbrace{abb}^{\text{Push}} \overbrace{g}^{\text{POP}}$
 Same Center has come.



$\Rightarrow w = \underline{aaaaa}$

$w = (q_0, \underline{aaaaa}, zw)$

$\delta(q_0, \underline{aaa}, a zw) \Rightarrow \text{Push}$

Push ↓ No center Center ↑ POP

$(q_0, aa, a a z o)$

Push ↓ No center

(q_1, aa, zw) At q_1 state $a, a/a$
 $b, b/b$; but here
 $a a, zw$, so Dead Configuration

$(q_0, a, a a a z o)$

Push ↓ POP

$(q_0, \epsilon, a a a z o)$
 X Dead Configuration

Center ↑ POP

$(q_0, a, \underline{a z o})$

one a is POP

Center ↑ POP

$(q_1, \epsilon, a a z o)$
 Dead Configuration

(q_1, ϵ, zw) 2nd a is POP

(q_2, ϵ, zw) Accept

③ Design a PDA that accepts all palindrome strings over $\Sigma = \{a, b\}$ & specify simulation for string aba (6m)

→ A palindrome will be of the form -

middle character

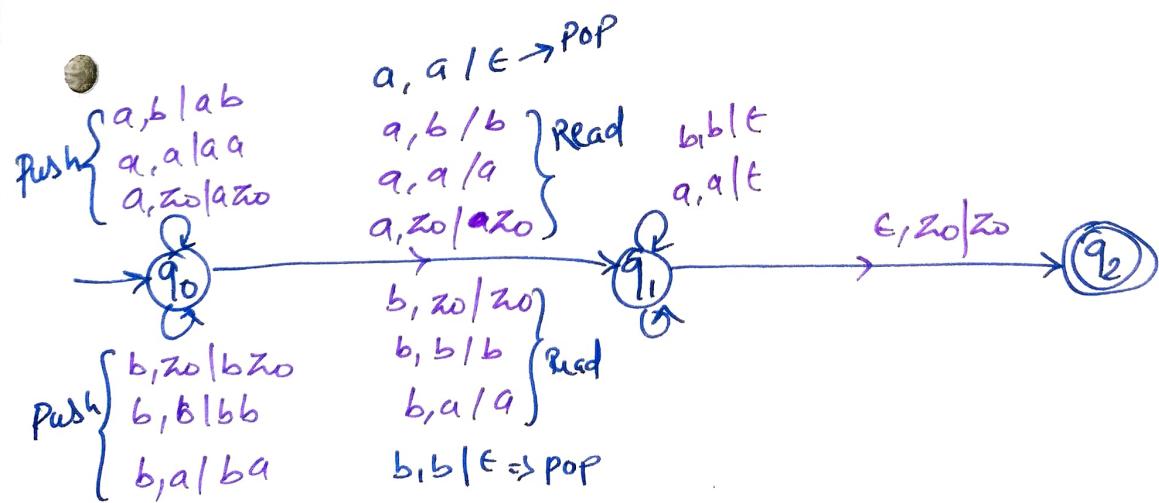
① ww^R ⇒ Even length palindrome ⇒ E

② waw^R } ⇒ odd length palindrome ⇒ a
 ③ wbw^R } ⇒ odd length palindrome ⇒ b

① w = aba

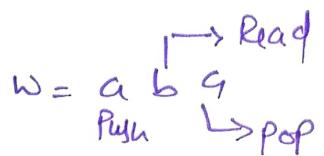
② aw = aa ⇒ w ∈ w
 ⇒ a ∈ a

~~8th~~ ③ w = aabbaa



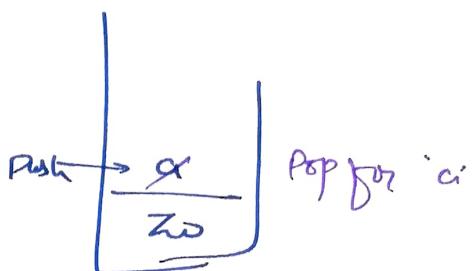
Simulation for $w = abg$

① $w = \underline{ab} g$



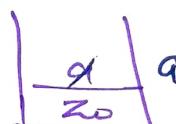
$$\delta(q_0, a, z_0) = (q_0, a z_0) \text{ Push}$$

$$\delta(q_0, b, a) = (q_1, a) \text{ Read}$$

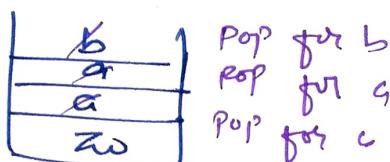


$$\delta(q_1, a, a) = (q_1, \epsilon) \text{ Pop}$$

② $w = a a = a \epsilon a$

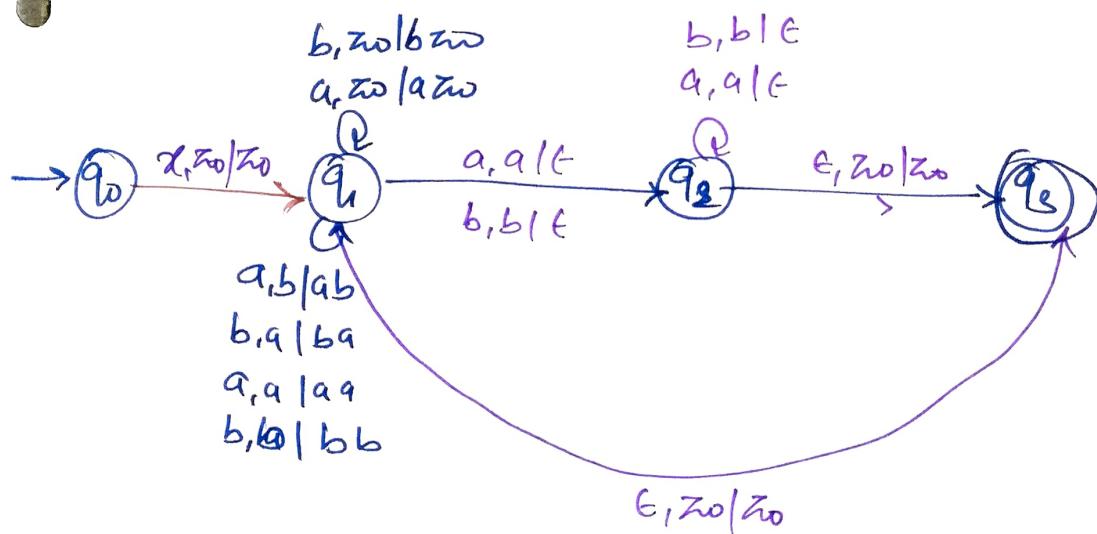


③ $aabbbaa$



④ $L = \{ x w w R \mid w \in (a, b)^* \}$

$\rightarrow L = \{ \epsilon, x, axabba, \dots \}$



$$w = xabba \cdot \epsilon \quad , \quad w = x \cdot \epsilon$$

$q_0 \rightarrow q_1 \rightarrow q_1 \rightarrow q_2 \rightarrow q_2 \rightarrow q_3$

$q_0 \rightarrow q_1 \rightarrow q_3$

* Equivalence of PDA & CFG

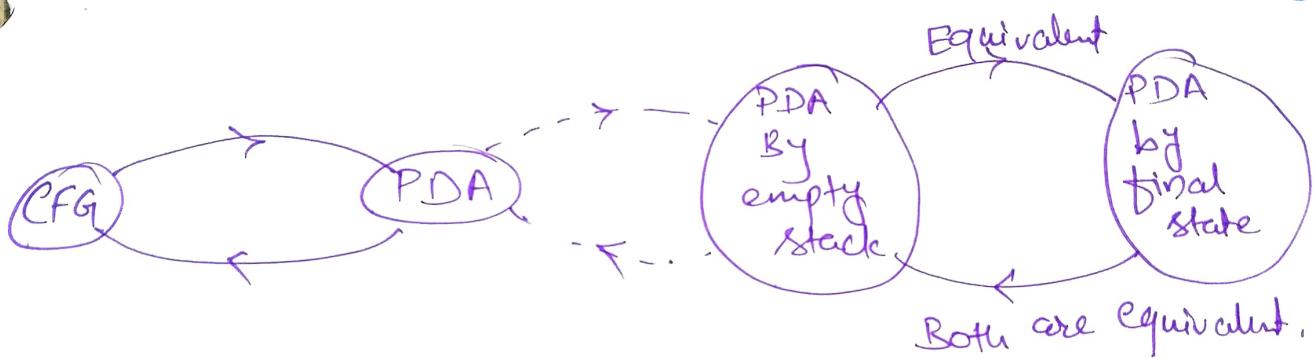
* CFG to PDA Conversion :-

CFG

PDA

$$G_1 = \{ V, T, P, S \}$$

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



⇒ If CFG is equivalent to PDA & there is

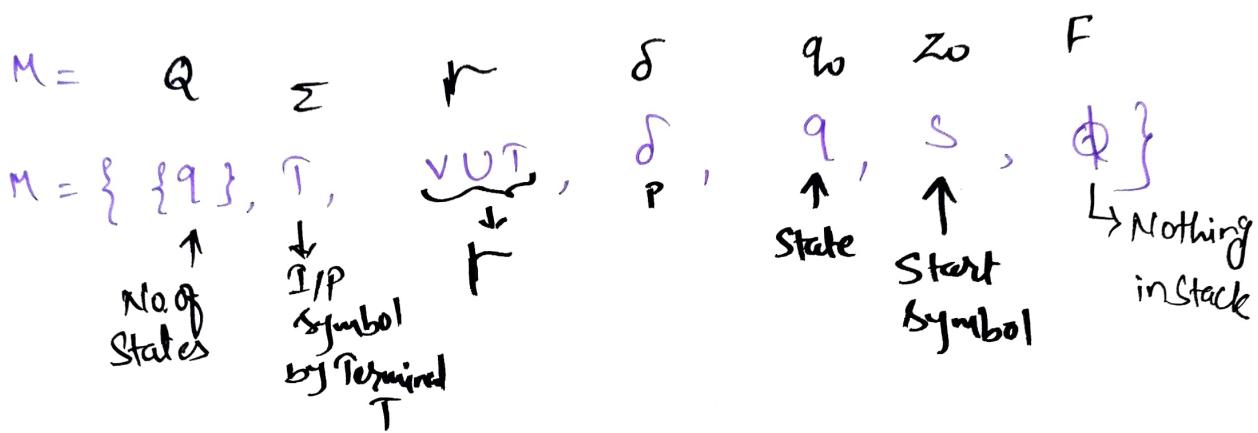
grammar equivalent to PDA then there is equivalence between them.

⇒ The class of languages accepted by PDA is exactly the class of CFG languages.

P:- $A \rightarrow \alpha$ is production

$A \in V, \alpha \in (V \cup T)^*$

\Rightarrow PDA accepting $L(G)$ by empty stack is given by -



Where,

$\delta: \textcircled{1} \quad \delta(q, \epsilon, A) \Rightarrow (q, \alpha)$ $\xrightarrow{\substack{\text{Pop of} \\ \text{Stack}}} A \text{ replaced by } \alpha \text{ i.e. Right side prod? of CFG}$

$\textcircled{2} \quad$ For every Terminal $a \in T$ (Pop op^γ)

$\delta(q, a, a) \Rightarrow (q, \epsilon) \Rightarrow \text{Pop}$