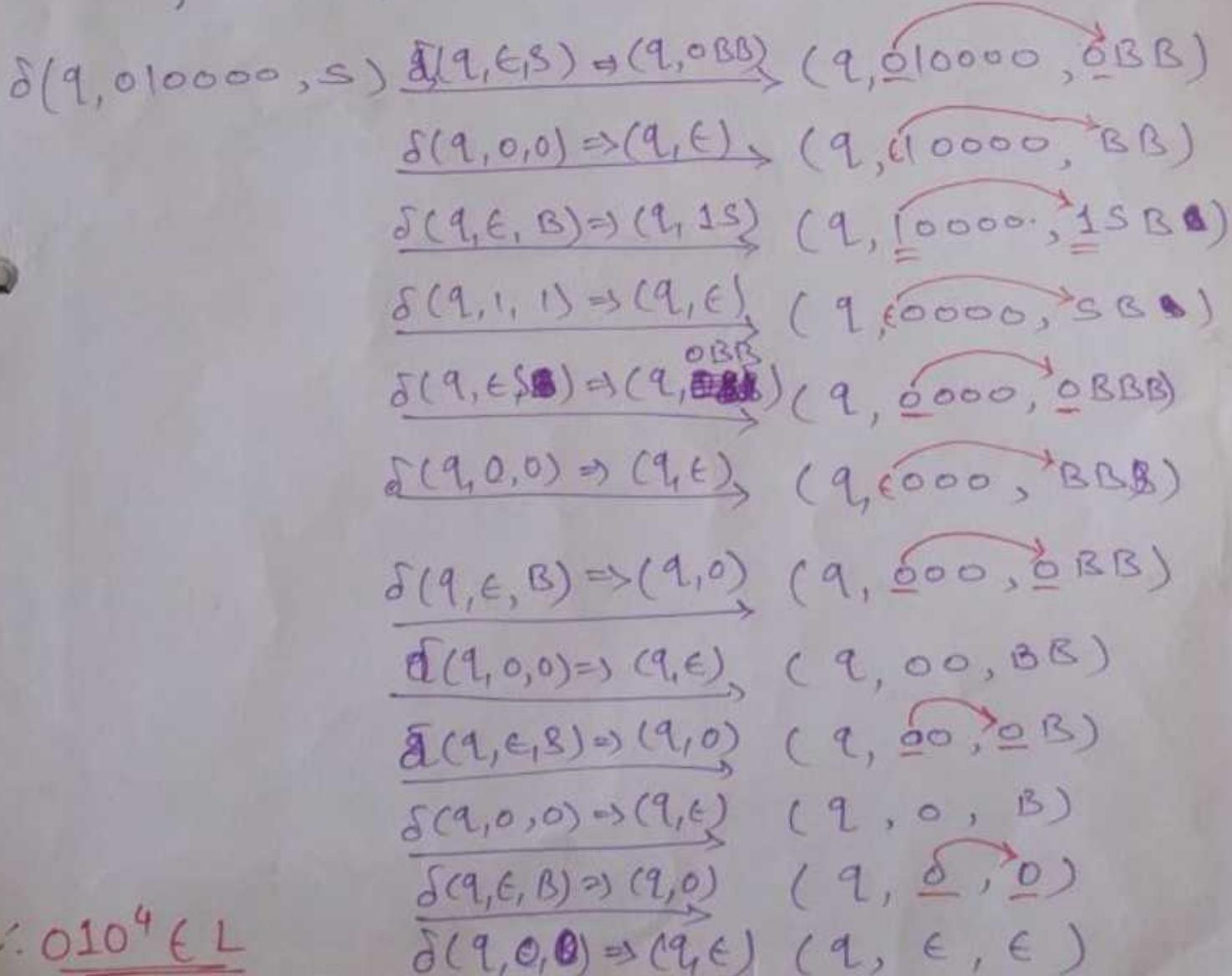


⑥ $S \rightarrow OBB$
 May 12, 13
 5M $B \rightarrow OS | 1S | 0$ Test if 010^4 is in language

$$\Rightarrow M = \left\{ (q), (0, 1), \frac{T}{\overline{\text{VUT}}}, \delta, q, S, \phi \right\}$$

$$\begin{aligned} \delta &:= \\ \delta(q, \epsilon, S) &\Rightarrow \{q, OBB\} \\ \delta(q, \epsilon, B) &\Rightarrow \{(q, OS), (q, 1S), (q, 0)\} \\ \delta(q, 0) &\Rightarrow (q, \epsilon) \\ \delta(q, 1) &\Rightarrow (q, \epsilon) \end{aligned} \quad \left. \begin{array}{l} \{ \} \\ \{ \} \\ T \end{array} \right\}$$

Acceptance of 010^4 by $M = 01\underline{0000}$



$\therefore \underline{010^4} \in L$

$$⑦ S \rightarrow aABB \mid aAA$$

$$A \rightarrow aBB \mid a$$

$$B \rightarrow bBB \mid A$$

$$\Rightarrow M = \{ (q), (a, b), (a, b, S, A, B), \delta, q, S, \phi \}$$

$$\begin{aligned} \delta: \quad & \delta(q, \epsilon, S) \Rightarrow \{(q, aABB), (q, aAA)\} \\ & \delta(q, \epsilon, A) \Rightarrow \{(q, aBB), (q, a)\} \\ & \delta(q, \epsilon, B) \Rightarrow \{(q, bBB), (q, A)\} \\ & \delta(q, a, a) \Rightarrow (q, \epsilon) \\ & \delta(q, b, b) \Rightarrow (q, \epsilon) \end{aligned} \quad \left. \begin{array}{l} \text{ } \\ \text{ } \\ \text{ } \\ \text{ } \end{array} \right\} T \quad \left. \begin{array}{l} \text{ } \\ \text{ } \\ \text{ } \\ \text{ } \end{array} \right\} V$$

$$⑧ S \rightarrow SS \mid (S) \mid () \quad \text{Aug 17 } \underline{\text{6M}}$$

Parentesis
Matching



$$\Rightarrow \delta \Rightarrow \delta(q, \epsilon, S) \Rightarrow \{(q, SS), \{q, (S)\}, \{q, (\})\} \Rightarrow V$$

$$\delta(q, (, ()) \Rightarrow (q, \epsilon) \quad \left. \begin{array}{l} \text{ } \\ \text{ } \end{array} \right\} T$$

$$\delta(q, (), ()) \Rightarrow (q, \epsilon) \quad \left. \begin{array}{l} \text{ } \\ \text{ } \end{array} \right\} T$$

$$① \delta(q, (()), S) \Rightarrow \delta(q, \epsilon, S) \xrightarrow{(q, (S))} (q, \underline{(}), \underline{(}))$$

$$\delta(q, (, ()) \Rightarrow (q, \epsilon) \xrightarrow{(q, (S))} (q, \underline{(}), \underline{S}))$$

$$\delta(q, \epsilon, S) \Rightarrow (q, (S)) \xrightarrow{(q, (S))} (q, \underline{(S)}, \underline{)})$$

$$\delta(q, (, ()) \Rightarrow (q, \epsilon) \xrightarrow{(q, (S))} (q, \underline{(S)}, \underline{)))}$$

$$\delta(q, (,)) \Rightarrow (q, \epsilon) \xrightarrow{(q, (S))} (q, \underline{(S)}, \underline{)})$$

$$\delta(q, (,)) \Rightarrow (q, \epsilon) \xrightarrow{(q, (S))} (q, \epsilon, \epsilon)$$

* PDA to CFG Conversion

CFG to PDA conversion is easy but PDA to CFG conversion is more difficult.

The basic idea is to consider any two states p, q of PDA M . & think about what strings could be consumed in executing M from p to q .

→ Those strings will be represented by a variable

$$V = \underline{\{p, a, q\}} \text{ in grammar } G_1.$$

→ Thus S is start symbol, will stand for all strings consumed in going from p to q to an accept state & for PDA we have to consider the stack

⇒ we can construct a grammar G_1 for any PDA M such that

$$\underline{L(G)} = L(M)$$

⇒ The variables of the CFG_1 , constructed will be of the form,

$$[p^x q], \text{ where } \underline{p, q \in Q} \text{ & } \underline{x \in F}$$

↑ State ↓ Stack symbol

Let PDA is given by,-

$$M = \{Q, \Sigma, \Gamma, \delta, q_0, z, \phi\}$$

\hookrightarrow Initial Stack symbol.

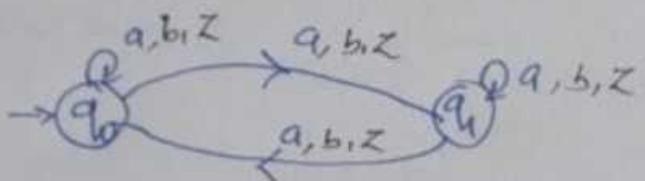
Then^{an} equivalent CFG is given by -

$$G = (V, \Sigma, P, S) \text{ where}$$

$$V = \{S, [P \times Q] \mid P, Q \in Q \text{ & } \times \in \Gamma\}$$

$$S \rightarrow [P \times Q] \quad \text{so} \quad S \rightarrow A \overset{x}{\underset{\alpha}{\Delta}} B$$

Ex:- If $Q = \{q_0, q_1\}$ & $\Gamma = \{a, b, z\}$ then the possible set of variables in the corresponding CFG is given by -



1) $S \rightarrow$ Start symbol

2) $[q_0^a q_0], [q_0^a q_1], [q_1^a q_0], [q_1^a q_1]$

3) $[q_0^b q_0], [q_0^b q_1], [q_1^b q_0], [q_1^b q_1]$

4) $[q_0 z q_0], [q_0 z q_1], [q_1 z q_0], [q_1 z q_1]$

* To convert PDA to CFG, we use the following three rules -

1) Add the following production for the start symbol S.

$S \rightarrow [q_0 \sqsupseteq q_i] ; \text{ for each } q_i \in Q, \text{ where } \sqsupseteq \text{ is start symbol.}$

2) For each transition of the form | Poping symbol from stack

Poping

$$\delta(q_i, a, B) \Rightarrow (q_j, C)$$

$$\delta(q_i, \underline{a}, B) \Rightarrow (q_j, \underline{C}) \Rightarrow \text{Poping}.$$

$$\textcircled{1} q_i, q_j \in Q ; \textcircled{2} a \in \{\Sigma \cup \epsilon\} \textcircled{3} B, C \in \{\Gamma \cup \epsilon\}$$

Poping can be done

Then for each $q \in Q$ we add the production

$$[q_i^B q_j] \xrightarrow{a} \underbrace{[q_j^C q]}_{\text{or}} \quad \text{or} \quad \underbrace{a}_{= q_j \text{ in } Q}$$

③ For each transition of the form $C_1 C_2$

Pushing

$$\delta(q_i, a, B) \Rightarrow (q_j, C_1 C_2)$$

~~Doesn't pop~~ Doesn't pop symbol from the stack (pushing)

Where,

$$\textcircled{1} q_i, q_j \in Q \textcircled{2} a \in \{\Sigma \cup \epsilon\} \textcircled{3} B, C_1, C_2 \in \{\Gamma\} \text{ No poping.}$$

Then for each $P_1, P_2 \in Q$, we add the productions.

$$[q_i^B P_1] \Rightarrow R a [q_j^G P_2] [P_2^{C_2} P_1]$$

OR

$$[q_i^B P_m] \Rightarrow a [q_j^G P_2] [P_2^{C_2} P_3] [P_3^{C_3} P_4] \dots \dots [P_{m-1}^{C_{m-1}} P_m]$$

* After defining all the rules, apply simplification of grammar to get reduced grammar.

① Convert PDA to CFG -

$$M = \{ (P, q), (q, P), (x, z), \delta, Pq, z \}$$

transition function δ is defined by -

$$\delta(\underline{q}, 1, z) \Rightarrow \{q, xx\}$$

$$\delta(q, 1, x) \Rightarrow \{q, xx\}$$

$$\delta(q, \epsilon, x) \Rightarrow \{q, \epsilon\}$$

$$\delta(q, 0, x) \Rightarrow \{P, x\}$$

$$\delta(P, 1, x) \Rightarrow \{P, \epsilon\}$$

$$\delta(P, 0, z) \Rightarrow \{q, z\}$$

$$q_0 = \{q\}$$

$$Q = \{P, q\}$$

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

$$V \cup T = \{x, z\} = F$$

$$S = \{z\}$$

⇒ ① Add the productions for start symbol 'S'

rule ① $S \rightarrow [q_0 z \underline{q_i}]$ for each $\underline{q_i} \in Q$.

$$Q = \{P, q\} = q_i$$

$$S \rightarrow [q z \underline{q}]$$

$$S \rightarrow [q z \underline{P}]$$