Q.1 Sequence of a's should be pushed onto the stack in state q_0.

i. $\delta(q_0, a, Z_0) = (q_0, aZ_0)$

ii. $\delta(q_0, a, a) = (q_0, aa)$

An 'a' should be popped for every b as input till the end of input.

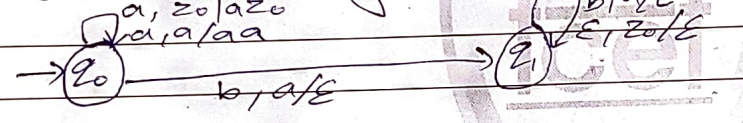
iii. $\delta(q_0, b, a) = (q_1, \varepsilon)$

iv. $\delta(q_0, b, a) = (q_1, \varepsilon)$

finally symbol Z_0 should be popped out to make the stack empty.

v. $\delta(q_1, \varepsilon, Z_0) = (q_1, \varepsilon)$

Transsion diagram:



Transition function

$\delta(q_0, a, Z_0) = (q_0, aZ_0)$

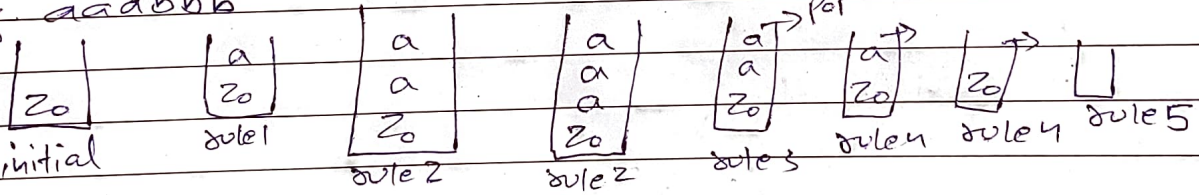
$\delta(q_0, a, a) = (q_0, aa)$

$\delta(q_0, b, a) = (q_1, \varepsilon)$

$\delta(q_1, b, a) = (q_1, \varepsilon)$

$\delta(q_1, \varepsilon, Z_0) = (q_1, \varepsilon)$

Eg. aaabbb



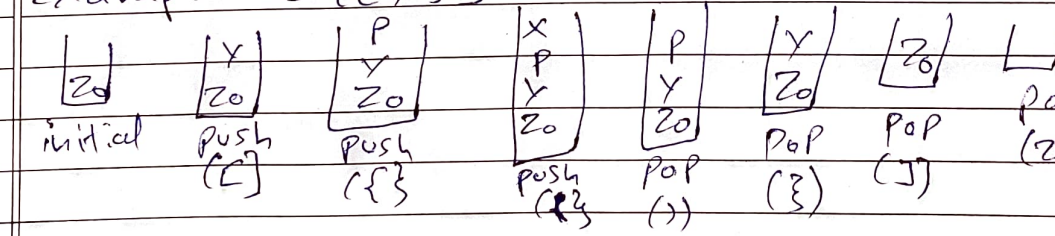
Q.2 i. for every '(' push one X into stack
ii. for every '[' push Y into stack
iii. for every '{' push P into stack
iv. for every ')' pop X from stack
v. for every ']' pop Y from stack
vi. for every '}' pop P from stack

Transition function :-

$\delta(q_0, (, Z_0) = (q_0, XZ_0)$
$\delta(q_0, [, Z_0) = (q_0, YZ_0)$
$\delta(q_0, \{, Z_0) = (q_0, PZ_0)$
$\delta(q_0, (, X) = (q_0, XX)$
$\delta(q_0, (, Y) = (q_0, XY)$
$\delta(q_0, (, P) = (q_0, XP)$
$\delta(q_0, [, X) = (q_0, YX)$
$\delta(q_0, [, Y) = (q_0, YY)$
$\delta(q_0, [, P) = (q_0, YP)$
$\delta(q_0, \{, X) = (q_0, PX)$
$\delta(q_0, \{, Y) = (q_0, PY)$
$\delta(q_0, \{, P) = (q_0, PP)$
$\delta(q_0, \}, P) = (q_0, \varepsilon)$
$\delta(q_0,), X) = (q_0, \varepsilon)$
$\delta(q_0,], Y) = (q_0, \varepsilon)$
$\delta(q_0, \varepsilon, Z_0) = (q_0, \varepsilon)$

Transition diagram

Example [{()}]



Q.3

i) Z_0 (topmost), input '0' → $\delta(q_0, 0, Z_0) = (q_0, 0Z_0)$

ii) Z_0 (topmost), input '1' → $\delta(q_0, 1, Z_0) = (q_0, 1Z_0)$

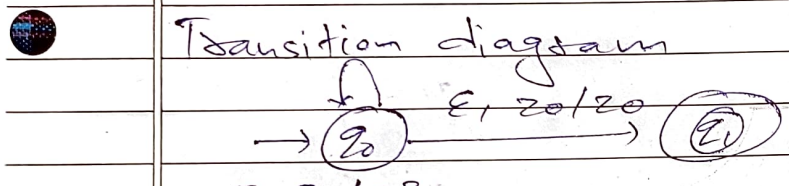
iii) 0 (topmost), input '0' → $\delta(q_0, 0, 0) = (q_0, 00)$

iv) 1 (topmost), input '1' → $\delta(q_0, 1, 1) = (q_0, 11)$

v) 0 (topmost), input '1' → $\delta(q_0, 1, 0) = (q_0, \varepsilon)$

vi) 1 (topmost), input '0' → $\delta(q_0, 0, 1) = (q_0, \varepsilon)$

Transition diagram



Transition function :-

$\delta(q_0, 0, Z_0) = (q_0, 0Z_0)$

$\delta(Z_0, 1, Z_0) = (q_0, 1Z_0)$

$\delta(q_0, 0, 1) = (q_0, \varepsilon)$

$\delta(q_0, 1, 0) = (q_0, \varepsilon)$

$\delta(q_0, 0, 0) = (q_0, 00)$

$\delta(q_0, 1, 11) = (q_0, 11)$

$\delta(q_0, \varepsilon, Z_0) = (q_1, Z_0)$

4. If a or b comes to the initial stack it will be pushed onto the stack and if c comes then will skip out 'c' or if c comes to initial state it will be sent to

$\delta(q_0, c, z_0) = (q_{11}, z_0)$

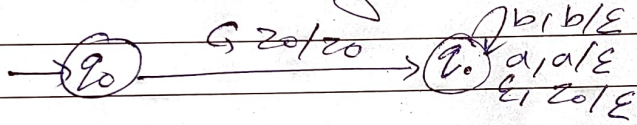
if the topmost matches with input (a or b) then it will be popped from the stack respectively.

$\delta(q_1, b, b) = (q_1, \varepsilon)$

$\delta(q_1, a, a) = (q_1, \varepsilon)$

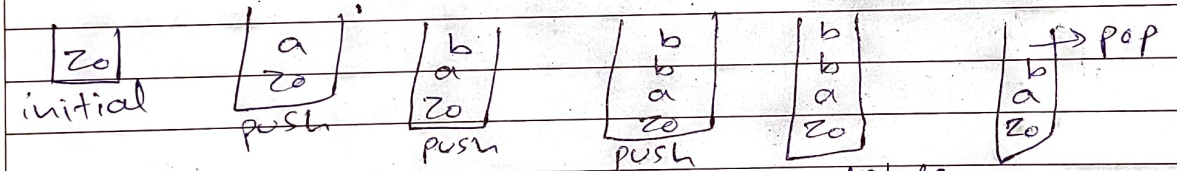
$\delta(q_{11}, \varepsilon, z_0) = (q_1, \varepsilon)$

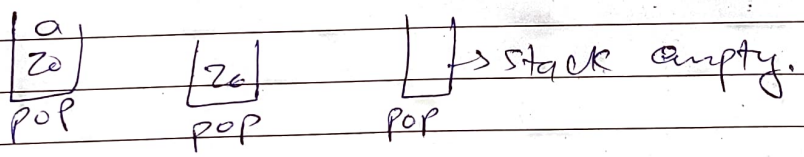
Transition diagram



a, z0 / a z0
a, a / a a
a b / a b
b, z0 / b z0
b, a / b a
b, b / b b

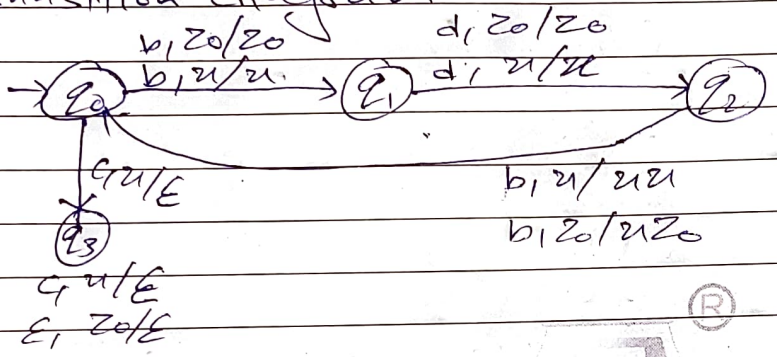
Eg. abbcbba





5. for every bdb one x ~~d~~ will be pushed and for each c one 'x' will be popped.

Transition diagram :-



Transition function.

$\delta(q_0, b, z_0) = (q_1, z_0)$

$\delta(q_1, d, z_0) = (q_2, z_0)$

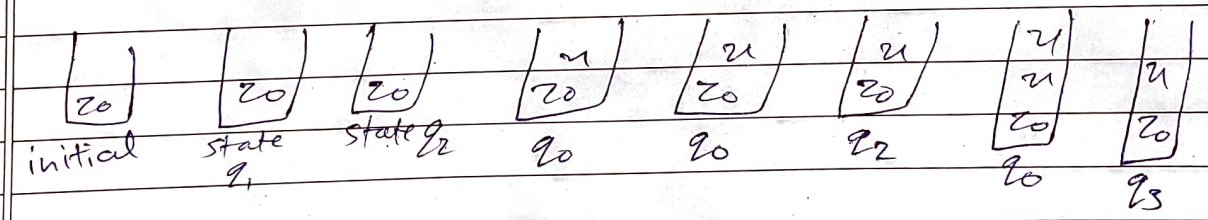
$\delta(q_0, b, x) = (q_0, xz_0)$

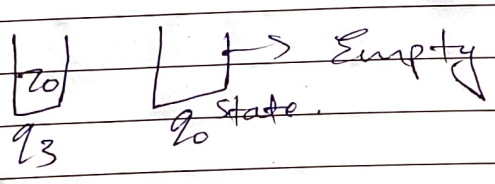
$\delta(q_1, d, x) = (q_1, x)$

$\delta(q_0, c, x) = (q_2, x)$

$\delta(q_3, c, x) = (q_3, \varepsilon)$

$\delta(q_3, \varepsilon, z_0) = (q_3, \varepsilon)$





8. $S \to aAA$

$A \to aS \mid bS \mid a$

Transition diagram :-

$\delta(q_0, \varepsilon, z_0) = \{(q_1, Sz_0)\}$

$\delta(q_1, a, S) = \{(q_1, AA)\}$

$\delta(q_1, a, A) = \{(q_1, S), (q_1, \varepsilon)\}$

$\delta(q_1, b, A) = \{(q_1, S)\}$

$\delta(q_1, \varepsilon, z_0) = \{(q_2, \$z_0)\}$

Example.

$\delta(q_0, abaaaa, z_0) \to \delta(q_1, abaaaa, Sz_0)$

$\to \delta(q_1, baaaa, AAz_0) \to \delta(q_1, aaaa, SAz_0)$

$S \to AA$ $A \to S$

$\to \delta(q_1, aaa, AAAz_0) \to \delta(q_1, aa, AAz_0)$

$S \to AA$ $A \to \varepsilon$

$\to \delta(q_1, a, Az_0) \to \delta(q_1, \varepsilon, z_0) \to \delta(q_1, \varepsilon, z_0)$.

$A \to \varepsilon$ $A \to \varepsilon$

9. If input string is given infix form we can convert it

Input A * B * C

prefix * * ABC

Let us PDA be represented as

$M = (Q, \Sigma, \delta, T, q_0, Z_0, F)$

Transition function :-

$\delta(q_0, +, Z_0) = (q_0, XZ_0)$

$\delta(q_0, -, Z_0) = (q_0, XZ_0)$

$\delta(q_0, *, Z_0) = (q_0, XZ_0)$

$\delta(q_0, /, Z_0) = (q_0, XZ_0)$

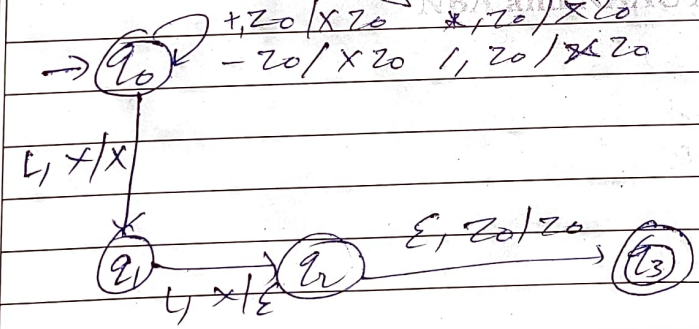
$\delta(q_0, L, X) = (q_1, X)$

$\delta(q_0, L, X) = (q_2, \varepsilon)$

$\delta(q_2, L, X) = (q_2, \varepsilon)$

$\delta(q_2, \varepsilon, Z_0) = (q_3, Z_0)$

Transition diagram



b. $S \rightarrow aSa \mid bSb \mid a \mid b \mid \varepsilon$

i. Removal of null productions:

$S \rightarrow aSa \mid bSb \mid a \mid b \mid aa \mid bb$

Converting it to CNF

$S \rightarrow AC \mid BO \mid a \mid b \mid AA \mid BB$

$A \rightarrow a$

$B \rightarrow b$

$C \rightarrow SA$

$D \rightarrow SB$

PDA is given by:

$M = (Q, \Sigma, \delta, T, Z_0, F)$

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

$T = \{S, A, B, C, D, Z_0\}$

Transition function :-

$\delta(q_0, \varepsilon, S) = (q_0, S)$

$\delta(q_0, K, S) = (q_0, C)$

$\delta(q_0, B, S) = (q_0, D)$

$\delta(q_0, A, S) = (q_0, \varepsilon)$

$\delta(q_0, B, S) = (q_0, \varepsilon)$

$\delta(q_0, A, S) = (q_0, A)$

$\delta(q_0, B, S) = (q_0, B)$

Transition diagram :-