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TE C3
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Assignment No 4

26/10

Q.1 Explain DPDA and NPDA with help of example.

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- DPAD (Deterministic Pushdown Automata)

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- In a DPAD there is only one move in every situation.
- A DPDA is less powerful than NPDA. Every context free language cannot be accepted by a DPDA.
- For example, a string of the form WW^R cannot be processed by a DPDA.
- The class of a language a DPDA can accepts lies in between a regular language and CFL.
- A DPDA can be defined as -

$$M = (Q, \Sigma, \Gamma, \delta, q_0, z_0, F)$$

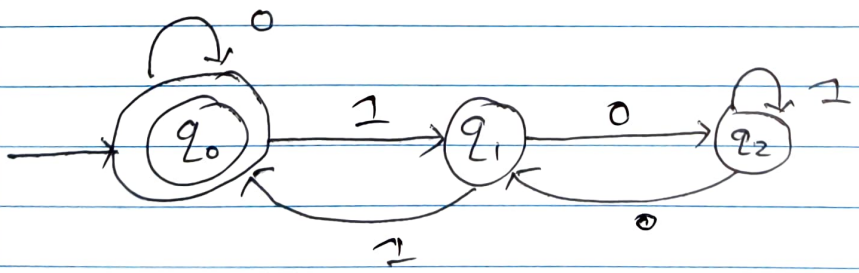
where,

$\delta(q, a, X)$ has one move for any $q \in Q$, $X \in \Gamma$ and $a \in \Sigma$.

- For e.g., DPDA for binary number divisible by 3.

⇒

- Transition diagram:



∴ DPDA is given by -

$M = [\{q_0, q_1, q_2\}, \{0, 1\}, \{0, 1, z_0\}, \delta, q_0, z_0, \{q_0\})$.

$\delta \Rightarrow$

δ / Σ	0	1
q_0	q_0	q_1
q_1	q_2	q_0
q_2	q_1	q_2

- **NPDA** (Non-deterministic PDA)

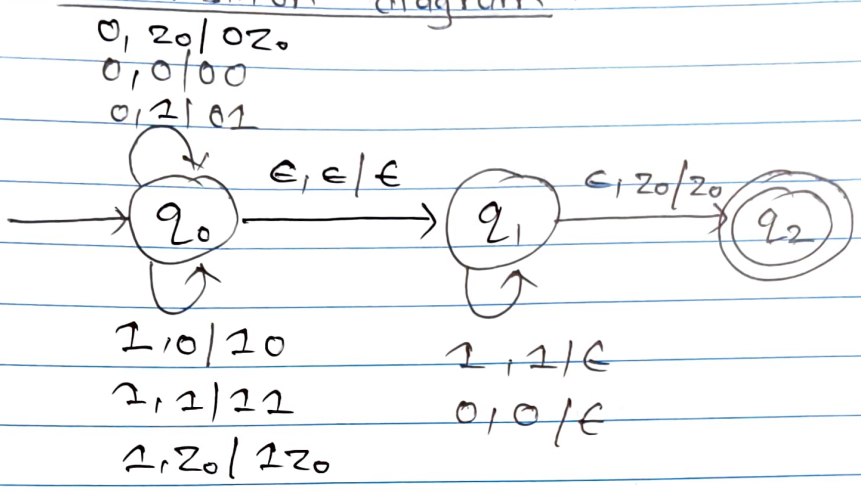
⇒

- A NPDA provides non-determinism to PDA.
- In DPDA, there is only one move in every situation. Where as, in case of NPDA there could be multiple moves under a situation.
- Every context free language cannot be recognized by a DPDA but it can be recognized by NPDA.
- The class of language a DPDA can accept lies in between a regular language and CFL.
- A palindrome can be accepted by NPDA but it can not be accepted by a DPDA.

Q. 2 Construct PDA accepting languages of Palindrome

⇒ Soln :-

- Transition diagram :



- Simulation :

I/P string : 10101

$$
\begin{aligned}
(q_0, 10101) &\vdash (q_0, 0101) \\
&\vdash (q_0, 0101) \\
&\vdash (q_0, 101) \\
&\vdash (q_0, 01) \\
&\vdash (q_0, 1) \\
&\vdash (q_0, \epsilon) \\
&\vdash (q_1, \epsilon) \\
&\vdash (q_2, \epsilon)
\end{aligned}
$$

∴ The 10101 string accepted.

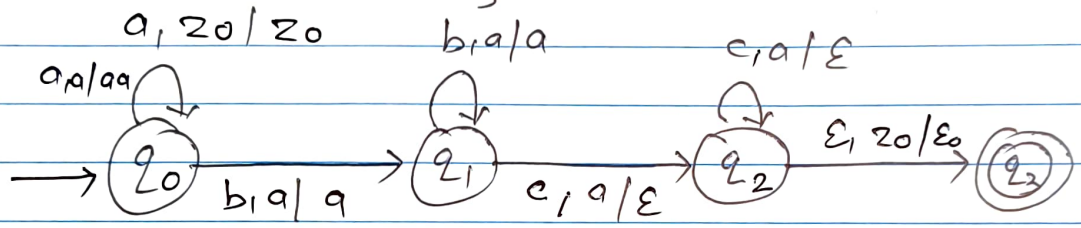
- PDA can be defined as -

$M = (\{q_0, q_1, q_2\}, \{0, 1\}, \{0, 1, Z_0\}, \delta, q_0, Z_0, \{q_2\})$.

Q.3 Construct PDA accepting the following languages $L = \{ a^n b^m c^n \mid m, n >= 1 \}$

⇒ Soln :-

- Transition diagram :



- Transition function :

$\delta(q_0, a, Z_0) = (q_0, aZ_0)$
$\delta(q_0, a, a) = (q_0, aa)$
$\delta(q_0, b, a) = (q_1, a)$
$\delta(q_1, b, a) = (q_1, a)$
$\delta(q_1, c, a) = (q_2, \varepsilon)$
$\delta(q_2, c, a) = (q_2, \varepsilon)$
$\delta(q_2, \varepsilon, Z_0) = (q_3, \varepsilon)$

- PDA can be defined as -

$M = (\{q_0, q_1, q_2, q_3\}, \{a, b, c\}, \{a, z_0\}, q_0, z_0, \{q_3\}, \delta)$

- Simulation :

$(q_0, aabbcc) \vdash (q_0, abbcc)$
$\vdash (q_0, bbcc)$
$\vdash (q_1, bcc)$
$\vdash (q_1, cc)$
$\vdash (q_2, c)$
$\vdash (q_2, \epsilon)$
$\vdash (q_3, \epsilon)$

∴ I/P string is accepted.

Q.4 Design PDA for the following CFG. Show acceptance of one of valid string

$S \rightarrow aAA$
$A \rightarrow bS$
$A \rightarrow aS$
$S \rightarrow a$

⇒ Soln :-

The equivalent PDA, M is given by

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

where δ is given by -

$\delta(q, \varepsilon, S) = \{(q, aAA)\}$
$\delta(q, \varepsilon, A) = \{(q, aS), (q, bS), (q, a)\}$

$\delta(q, a, a) \Rightarrow \{(q, \varepsilon)\}$
$\delta(q, b, b) \Rightarrow \{(q, \varepsilon)\}$

- Acceptance of aba^4 by M

$\delta(q, abaaaa, S) \vdash (q, baaaa, aAA)$
$\vdash (q, baaaa, AA)$
$\vdash (q, aaaa, SA)$
$\vdash (q, aaaa, SA)$
$\vdash (q, aaaa, OAAA)$
$\vdash (q, aaa, AAA)$
$\vdash (q, aaa, aAA)$
$\vdash (q, aa, AA)$
$\vdash (q, aa, OA)$
$\vdash (q, a, A)$
$\vdash (q, a, a)$
$\vdash (q, \varepsilon, \varepsilon)$.

Thus, the string aba^4 is accepted by M using an empty stack.

$\therefore aba^4 \in L$.