F.A.

$a \in \Sigma^*$ | $a \in \Sigma^*$

* Examples :

Q.7 QB

(1)

$S \rightarrow ACaB$

$Bc \rightarrow acB$

$CB \rightarrow DB$

$aD \rightarrow Db$.

Since all the given productions $\alpha \rightarrow \beta$, satisfy the conditions.

where,

$\alpha \in (\Sigma \cup V_n)^* V_n (\Sigma \cup V_n)^*$

$B \in (\Sigma \cup V_n)^+$

$|\alpha| \leq |\beta|$

∴ The above given grammar is of Type 1 grammar i.e context sensitive grammar.

It is also Type 0 Grammar ~~since~~ i.e Unrestricted grammar.

No.
Date

(2) $S \rightarrow Xa$
$X \rightarrow a$
$X \rightarrow aX$
$X \rightarrow abc$
$X \rightarrow \epsilon$

Since all the given productions $\alpha \rightarrow \beta$, satisfy the following conditions where,

α ~~α~~ $\in V_n$ $|\alpha| = 1$
$\beta \in (\Sigma \cup V_n)^*$

The above given grammar is of Type 2 grammar i.e Context Free Grammar.

(3) $X \rightarrow \epsilon$
$X \rightarrow a \mid aY$
$Y \rightarrow b$

Since all the given productions $\alpha \rightarrow \beta$, satisfy the conditions where,

$\alpha \rightarrow \beta$.
eg $A \rightarrow a \mid aB$
$A, B \in V_n$ $|A| = |B| = 1$
$a \in \Sigma^*$

The above given grammar is of Type 3 Grammar i.e Regular Grammar.

(4) $AB \rightarrow AbBc$

$A \rightarrow bc$

$B \rightarrow b$

Since all the given productions are $\alpha \rightarrow \beta$, satisfy the conditions,

where,

$\alpha \in (\Sigma \cup V_n)^* V_n (\Sigma \cup V_n)^*$

$\beta \in (\Sigma \cup V_n)^+$

$|\alpha| \leq |\beta|$

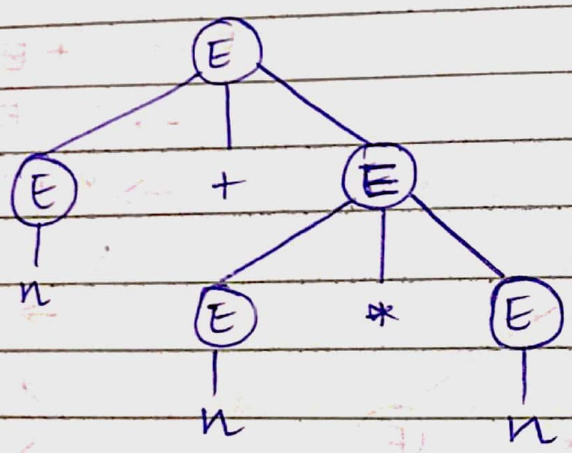
∴ The above given grammar is of Type 1 grammar i.e Context Sensititive Grammar

It is also Type 0 grammar i.e unrestricted gramma

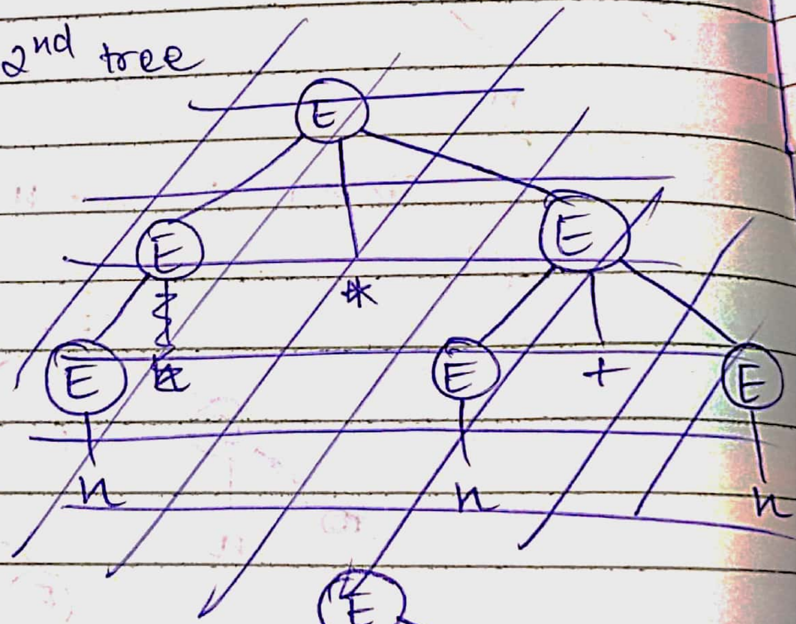
eg $E \to E+E$
$\to n+E$
$\to n+E*\cancel{S}E$
$\to n+n*S$
$\to n+n*n$

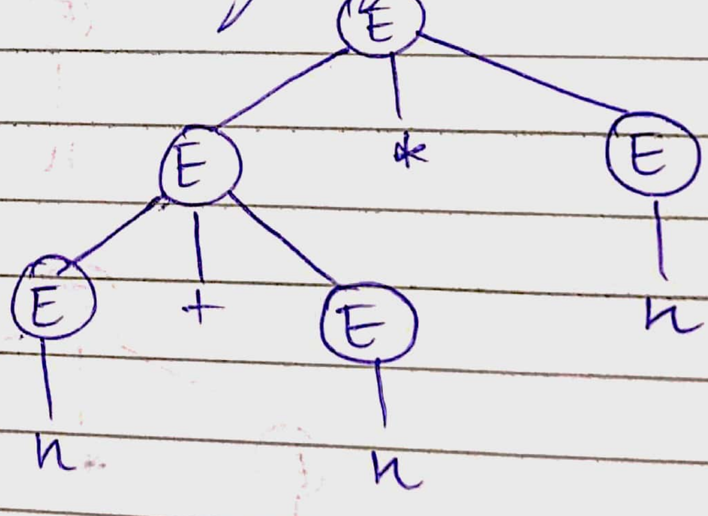
$E \to \underline{E*E}$
$\to E+E*E$
$= n+E*E$
$= n+n*E$
$= n+n*\cancel{E}n$

1st tree



2nd tree





QB Q3] Given grammar :

$$S \rightarrow ASA \mid aB$$
$$A \rightarrow B \mid S$$
$$B \rightarrow b \mid \epsilon$$

Step 1 : Remove null productions .

$$S \rightarrow ASA \mid aB \mid a$$
$$A \rightarrow S \mid \cancel{G}\, B .$$
$$B \rightarrow b \cancel{\epsilon}$$

$$S \rightarrow ASA \mid aB \mid a \mid S \mid AS \mid SA .$$
$$A \rightarrow S \mid B$$
$$B \rightarrow b$$

Step 2 : Remove unit productions .

$$\cancel{S \rightarrow SSS \mid aB \mid a \mid S \mid SS \mid SS .}$$
$$\cancel{A\ B \rightarrow b}$$

$$S \rightarrow ASA \mid aB \mid a \mid \cancel{S} \mid AS \mid SA$$
$$A \rightarrow b \mid ASA \mid aB \mid a \mid \cancel{S} \mid AS \mid SA .$$
$$B \rightarrow b .$$

Step 3 : Remove useless symbols .
since there are no useless symbols -
we move on further .

Step 4: chomsky converter.

$S \rightarrow AD_1 \mid B_aB \mid a \mid AS \mid SA$.

$D_1 \rightarrow SA$

$B_a \rightarrow a$

$A \rightarrow AD_1 \mid SA \mid b \mid a \mid B_aB \mid AS \mid \cancel{SA}$

$B \rightarrow b$.

$\therefore S \rightarrow AD \mid CB \mid a \mid AS \mid SA$.

$D \rightarrow SA$.

$C \rightarrow a$

$A \rightarrow AD \mid SA \mid b \mid a \mid CB \mid AS$.

$B \rightarrow b$.

This is the required grammar.

Scanned with CamScanner

~~QB~~ Q4]

$A \rightarrow BAB \mid B \mid \epsilon$
$B \rightarrow 00 \mid \epsilon$.

Step 1 : Remove null productions.

Nullable ~~variables~~ = $\{A, B\}$.

$A \rightarrow BAB \mid B \mid \epsilon \mid BA \mid AB \mid A$.
$B \rightarrow 00$

$A \rightarrow BAB \mid B \mid BA \mid AB \mid A \mid BB$
$B \rightarrow 00$.

Step 2 : Remove unit production.

$A \rightarrow BAB \mid 00 \mid BA \mid BB \mid AB$.
$B \rightarrow 00$.

Step 3 : Remove useless production
Since there are no useless productions.
we move on further.

Step 4 : Chomsky converter.

$A \rightarrow BD \mid 00 \mid BA \mid BB \mid AB$
$B \rightarrow 00$
$D \rightarrow AB$.

$A \rightarrow BD \mid CC \mid BA \mid BB \mid AB$
$B \rightarrow CC$
$D \rightarrow AB$.
$C \rightarrow 0$

* Pumping lemma for CFL.

Let L be a CFL

Let n be a constant.

Any string z in L $|z| \geq n$

Split $z = uvwxy$ such that

i) $|vwx| \leq n$

ii) $|vx| \geq 1$ or $vx \neq \varepsilon$

iii) For all $i = 0$, $uv^iwx^iy \in L$.

Q6] $L = \{x^n y^n z^n \mid n \geq 1\}$ is context free or not.

Step 1: Let L be a context Free language

Step 2: Let $Z = x^n y^n z^n$ such that $|Z| \geq n$. where n is the pumping lemma constant.

Step 3: As per pumping lemma, $z = uvwxy$ where $|vwx| \leq n$ and $|vx| \geq 1$ such uv^iwx^iy where $i \geq 0$ would belong to L

Step 4: Let $n = 3$.

$L = \{ xyz, xxyyzz, xxxyyyzzz \ldots \}$

$\therefore Z = x^3y^3z^3$

$|Z| \geq n$

$|x^3y^3z^3| \geq 3$

$9 \geq 3$

$\underbrace{xx}_{u}\,\underbrace{x}_{v}\,\underbrace{y}_{w}\,\underbrace{y}_{x}\,\underbrace{yzzz}_{y}$

$u = xx$
$v = x$
$w = y$
$x = y$
$y = yzzz$

Cond^n 1 :

$\therefore \; |vwx| \leq n$.

$|xyy| \leq 3$

$3 \leq 3$. ✓

Cond^n 2 :

~~$1 \leq |vx| \leq n$~~ $|vx| \geq 1$

$|x.y| \geq 1$

$2 \geq 1$ ✓

For $i \geq 0$ $\quad uv^iwx^iy \in L$.

$i = 0 \quad xx\,x^0\,y\,y^0\,yzzz \in L$.

$z = xxyyzzz \notin L$.

$\because$ our assumption that L is a context free language is wrong.

* closure properties of CFL.

1. union. ✓
2. Concatenation ✓
3. Kleene closure. ✓

→ If L_1 and L_2 are CFL and G_1 and G_2 be their grammar respectively.

Proof :

(i) union

Let $L_1 = \{ a^n b^n, n \geq 1 \}$

then there exist a corresponding grammar.

$G_1 = \{ S_1 \rightarrow aS_1b \mid ab$.

Let $L_2 = \{ c^m d^m, m \geq 1 \}$

$G_2 = S_2 \rightarrow cS_2d \mid cd$.

~~then there exists a~~

the union of L_1 & L_2 is $L_1 \cup L_2$

then corresponding grammar is $G : S \rightarrow S_1 | S$

$\therefore S \rightarrow S_1 \mid S_2$

$S_1 \rightarrow aS_1b \mid ab$

$S_2 \rightarrow cS_2d \mid cd$.

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(ii) concatenation

Let $L_1 = \{a^n b^n \mid n \geq 1\}$

corr grammar,

G_1 : $S_1 \to aS_1b \mid ab$.

Let $L_2 = \{c^m d^m ; n \geq 1\}$

corr grammar

G_2 : $S \to cS_2d \mid cd$.

then concatenation of L_1 and L_2 is $L_1 . L_2$

then G_1 : $S \to S_1 . S_2$.

$S_1 \to aS_1b \mid ab$

$S_2 \to cS_2d \mid cd$.

(iii) Kleene closure :

Let $L_1 = \{a^n b^n , n \geq 1\}$

then corr grammar

G_1 : $S_1 \to aS_1b \mid ab$.

L^* is $(a^n b^n)^* = \{\epsilon, (a^n b^n)^1, (a^n b^n)^2, \ldots$

$n \geq 1$

$S \to SS_1 \mid \epsilon$.

$S_1 \to aS_1b \mid ab$.

Module 4

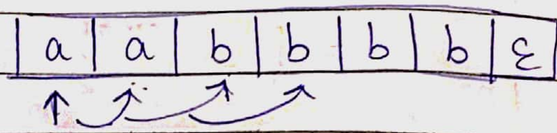
QB

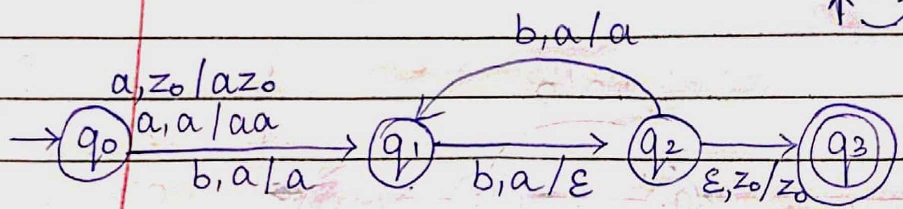
Q1.

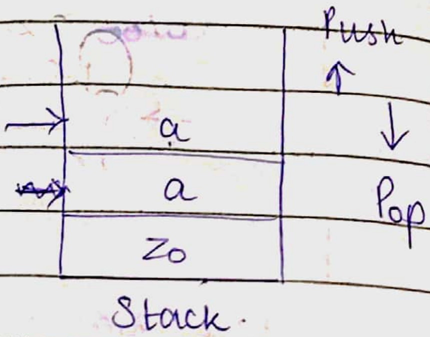
$\{a^n b^{2n} \mid n \geq 1\}$

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

$L = \{abb, aabbbb, \ldots\}$







Transitions :

$q_0, a, z_0 \rightarrow q_0, az_0$

$q_0, a, a \rightarrow q_0, aa$

$q_0, b, a \rightarrow q_1, a$

$q_1, b, a \rightarrow q_2, \varepsilon$

$q_2, b, a \rightarrow q_1, a$.

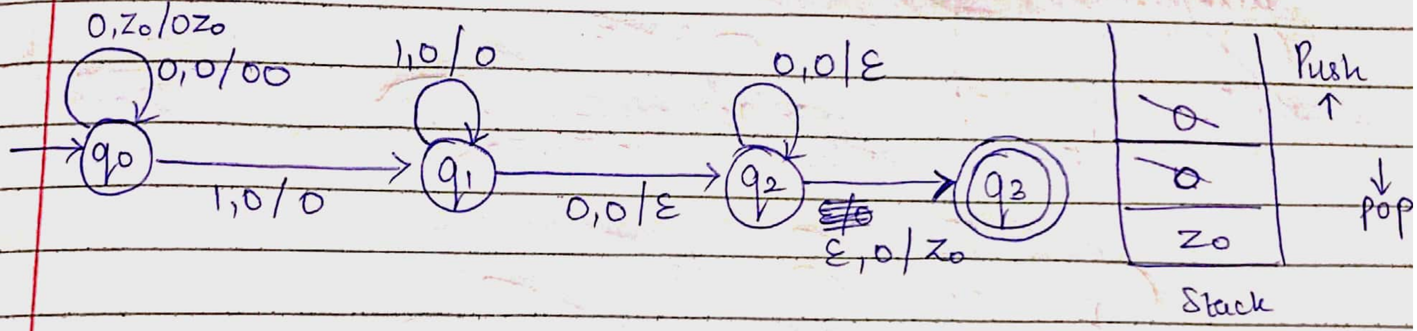
$q_2, \varepsilon, z_0 \rightarrow q_3, z_0$.

module 4 QB

Q2] ~~Con~~ $\{0^n 1^m 0^n \mid m,n \geq 1\}$

$L = \{010, 00100, 0110, \ldots\}$

0	0	1	1	1	0	0	ε



$\delta(q_0, a, z_0) \rightarrow (q_0, az_0)$
$\delta(q_0, a, a) \rightarrow (q_0, aa)$
$\delta(q_0, 1, 0) \rightarrow (q_1, 0)$
$\delta(q_1, 1, 0) \rightarrow (q_1, 0)$
$\delta(q_1, 0, 0) \rightarrow (q_2, \varepsilon)$
$\delta(q_2, 0, 0) \rightarrow (q_2, \varepsilon)$
$\delta(q_2, \varepsilon, Z_0) \rightarrow (q_3, z_0)$

~~PDA, P = ({q0, q1, q2, q3} q4, {a, b, c {0, 1}~~.

QB M4
Q4]

DPDA	NPDA
1) It is less powerful than NPDA eg) It can be used to construct only odd-length palindromes and not even-length palindromes.	1) It is more powerful than DPDA. eg) It can be used to construct both odd and even length palindromes.
2) It is possible to convert every DPDA into corresponding NPDA.	2) It is not possible to convert every NPDA into corresponding DPDA.
3) The language accepted by DPDA is a subset of the language accepted by NPDA.	3) The language accepted by NPDA is not a subset of the language accepted by DPDA.
4) The language accepted by DPDA is called DCFL (Deterministic Content Free language)	4) The language accepted by NPDA is called NCFL (Non-deterministic content free language)
5) There is only one state transition from one state to another state for an input symbol	5) There ~~is~~ ~~not~~ may or may not be more than one state transition from one state to another state for same input symbol.

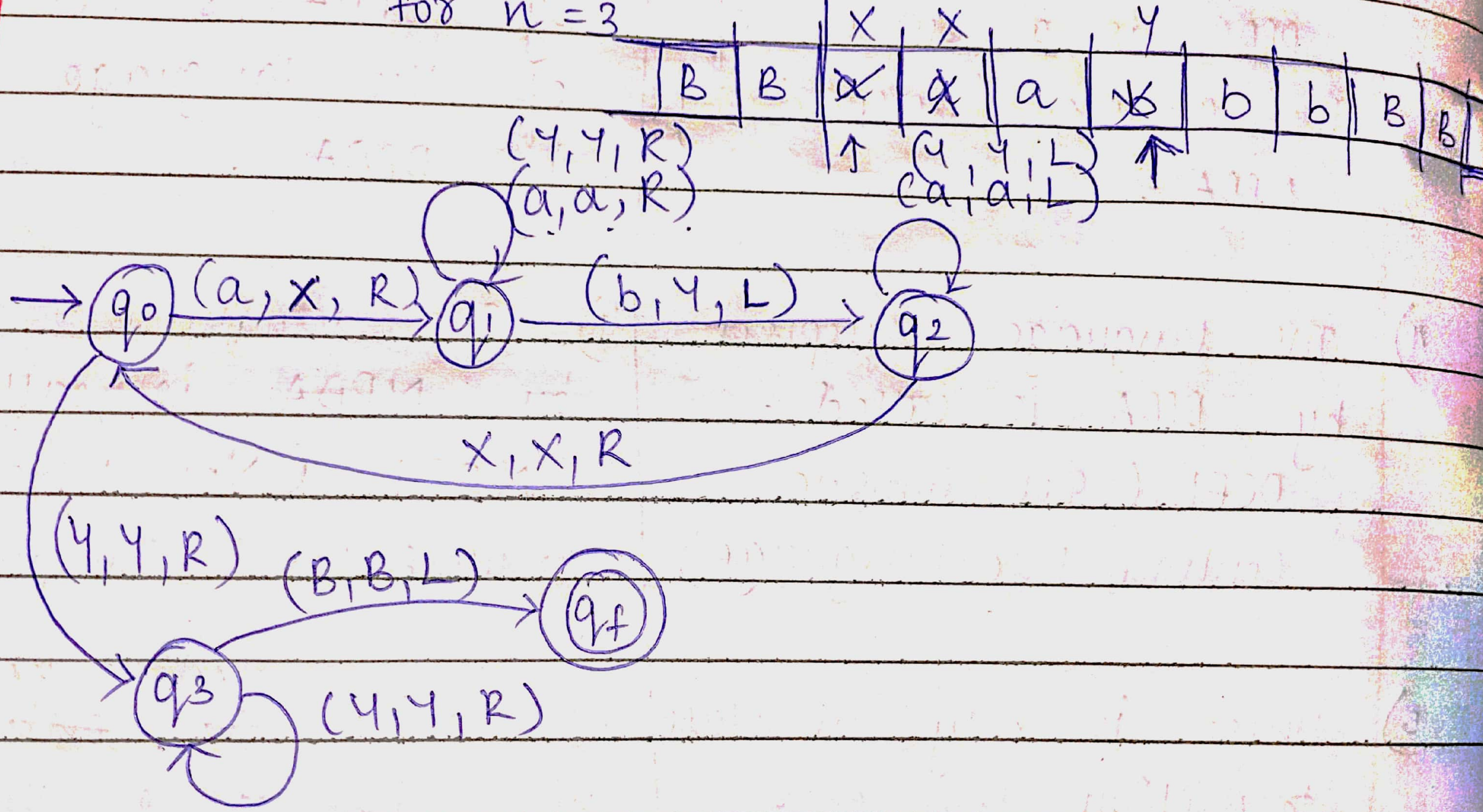
in both left, right.

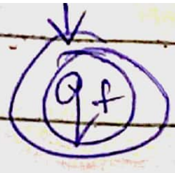
QB MS

Q2

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

for $n=3$





QB M5
Q1.]

Turing machine 2's complement of binary number.

~~01011000~~.

Let the input = 01011,000