Sol.1.a)

	NFA	DFA
i)	No. of state is less.	No. of state is more as compared to NFA.
ii)	No. of transition is limited	No. of transition is more
iii)	There is no provision for transition of every input.	There should be a transition for every possible input.
iv)	Dead State is not necessary.	Dead state is necessary.

Sol.1.b) Given,

Mealy Machine:

	a = 0 state	o/p	a = 1 state	o/p
q_1	q_1	1	q_2	0
q_2	q_4	1	q_4	1
q_3	q_2	0	q_3	1
q_4	q_3	0	q_2	1

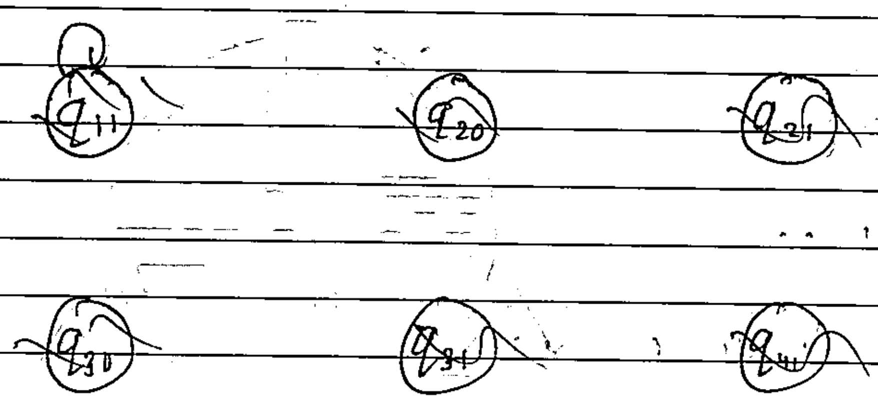
$q_1 \rightarrow q_{11}$

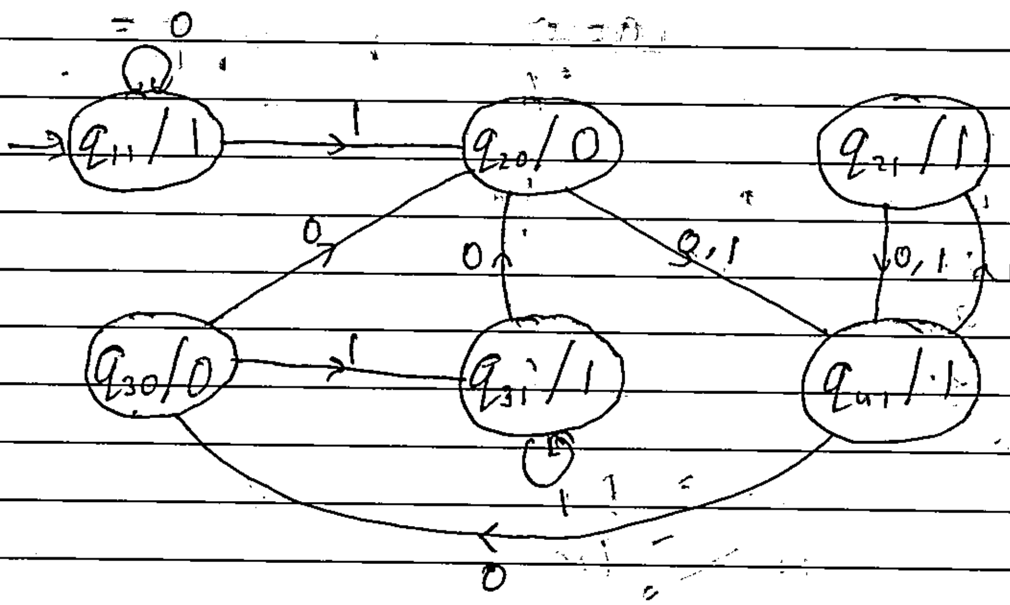
$q_2 \rightarrow q_{20}$, $q_2 \rightarrow q_{21}$

$q_3 \rightarrow q_{30}$, $q_3 \rightarrow q_{31}$

$q_4 \rightarrow q_{41}$

States	a = 0	a = 1	O/p
~~q_1~~ ~~q_1~~ q_{11}	q_{11}	q_{20}	1
~~q_2~~ q_{20}	q_{41}	q_{41}	0
~~q_3~~ q_{21}	q_{41}	q_{41}	1
~~q_4~~ q_{30}	q_{20}	q_{31}	0
q_{31}	q_{20}	q_{31}	1
q_{41}	q_{30}	q_{21}	1





Ans

Sol.1.c) Given,

State / Σ	0	1
$\rightarrow q_0$	q_1	q_4
q_1	q_2	q_3
q_2	q_7	q_8
q_3	q_8	q_7
q_4	q_5	q_6
q_5	q_7	q_8
q_6	q_7	q_8
q_7	q_7	q_7
q_8	q_8	q_8

	q_0	q_1	q_2 *	q_3 *	q_4	q_5 *	q_6 *	q_7	q_8
q_0									
q_1									
* q_2	✓	✓							
* q_3	✓	✓	✓						
q_4			✓	✓					
* q_5	✓	✓	✓	✓	✓				
* q_6	✓	✓	✓	✓	✓	✓			
q_7			✓	✓		✓	✓		
q_8			✓	✓		✓	✓		

Step 1: Tick mark all pair of (Final - Final) state

Step 2: Then Tick mark all pair of Final - Non Final or Non Final - Final states

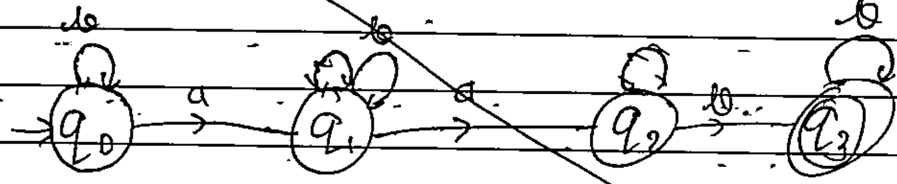
Step 3: Group them ~~to~~ be minimize.

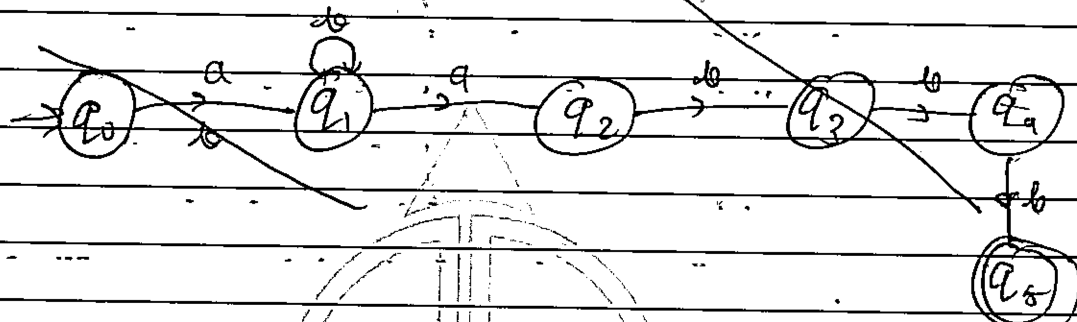
$\{q_0, q_1, q_4, q_7, q_8\}\ \{q_2, q_3, q_5, q_6\}$

$\Rightarrow \{q_0\}\{q_7\ q_8\}\{q_7\ q_4\}\ \{q_2, q_3, q_5, q_6\}$ Ans

Sol.1.d $L = \{w$ where no of $a = 2$ & $b \geq 3\}$

$= \{aabbb, ababb, ababbb, bababb, \ldots\}$





Sol 9.) Closure property of Regular Grammer :-

i) If given grammer G_1 & G_2 are Regular grammar then, union property of $L_1 \cup L_2$ is always regular grammer.

ii) If given grammer g_1 & g_2 are regular grammer then, intersection $L_1 \cap L_2$ is not always regular grammer.

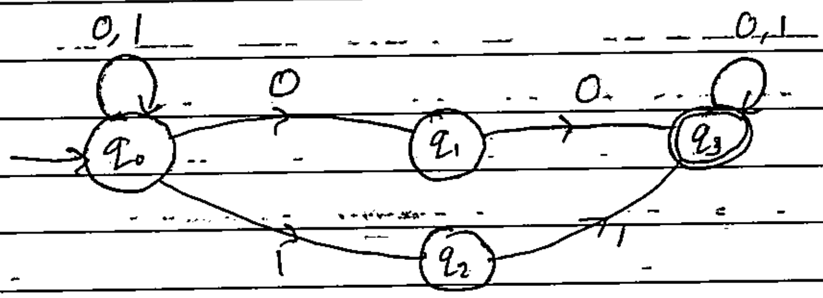
iii) If given grammer g_1 & g_2 are regular grammer then ~~its~~ complement is not always Regular grammer.

iv) If given grammer g_1 & g_2 are regular grammer, then difference $L_1 - L_2$ is not always Regular.

Sol.

Sol. 2.) Given, Regular expression,

$$(0+1)^* (00+11) \cdot (0+1)^*$$



$L = \{00, 11, 0001, 0110, 011, 111, \ldots\}$

Transition table:

	0	1
q_0	q_0, q_1	q_0, q_2
q_1	q_3	ϕ
q_2	ϕ	q_3
q_3	q_3	q_3

Sol.2) Given, $L = \{a^n b^n \text{ where } n \geq 1\}$
$= \{ab, aabb, aaabbb, \dots\}$

Let $p = 3$ $\quad$ aaa bbb

Conditions of Pumping Lemma.

i) $xy^iz \in L$ where $i = 0, 1, 2, \dots n$

ii) $|y| > 0$

iii) $|xy| \leq p$

For $p = 2$ $\quad$ aa bb

Case 1: $x = a$, $y = ab$, $z = bb$

~~xy~~ For

For $i = 1$,

$\cancel{x}$ $xyz = a\,a\,bb \in L$

$\cancel{i=2}$

$i=2:\ xy^2z = a\,a\,a\,bb \notin L$

Case 2: $x = \cancel{aa}\ \epsilon$, $y = aa$, $z = bb$

$i=1:\ xy^1z = \epsilon.\,aabb = aabb \in L$

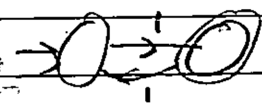
$i=2:\ xy^2z = \epsilon.\,aaaa.bb = aaaabb \notin L$

∴ Since, it does not belong to L, then,

∴ it is not Regular.

Sol.3.a) Given, ~~L = {n0~~

L = odd no. of 1's



$L = \{1, 111, 11111, 1111111, \ldots\}$

$= \cancel{1^*}\ 1.(11)^*$

$1^*.1.1^*$

b) L = "String ending in 00" $= \{00, 100, 000, 0100, \ldots\}$

$= (0+1)^*.00$

Sol 3.(b) In Chomsky Classification of Grammer, there are 4 type of grammer

i) Type-0 Grammer or Recursive Enumerable Grammer :

- This is the unrestricted grammer.
- If $\alpha \rightarrow \beta$
then, $\alpha \in (V+T)^+$ Ex: $AS \rightarrow Vab$
$\beta \in (V+T)^*$

- It is automated by using Turing Machine.

ii) Type-1 Grammer or Context Sensitive Grammer:

- ~~It is~~ There is some restriction in this grammer
- If $\alpha \rightarrow \beta$

$\alpha \in (V+T)^+$
$\beta \in (V+T)^+$ Ex: $A \rightarrow Ba$
$Ab \rightarrow aPq$

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

- It is automated with the help of LBA
Limited Bound Automation.

iii) Type – II Grammar or Context Free Grammar :-

- If $\alpha \rightarrow \beta$

$\alpha \in V$ where $|\alpha| = 1$

$\beta \in (V+T)^*$

Ex: $A \rightarrow B$

$B \rightarrow a P s$

$P \rightarrow m P Q$

$Q \rightarrow P m$

- It is automated using Push Down Automata (PDA)

iv) Type-III Grammar or Regular Grammar

- If $\alpha \rightarrow \beta$

$\alpha \in V$

$\beta \in (V+T)^*$

where $|\alpha| = 1$

There are two type of Regular grammar :

a) Left ~~most~~ Regular Grammar :

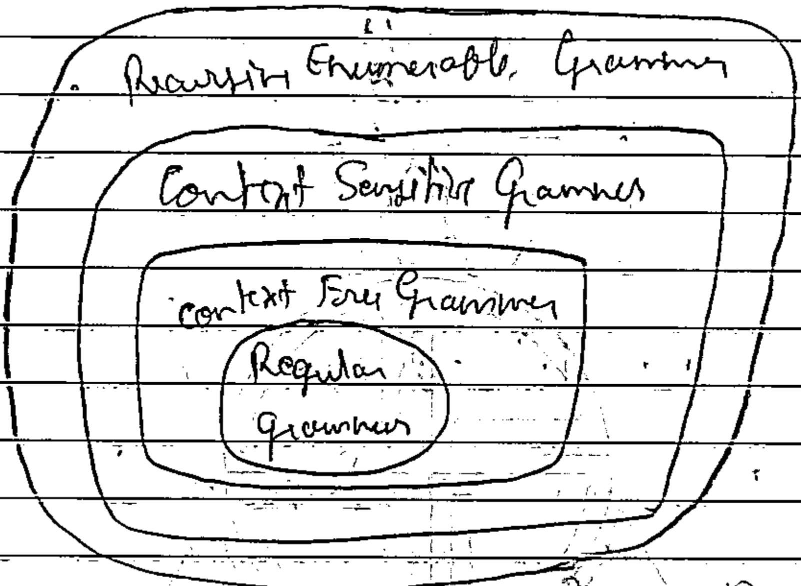
Ex: $A \rightarrow A a b$

Here in RHS, Left RHS must start with Variable.

d) Right Regular Grammar:

- In this, ~~the variable must~~ there ~~may~~ must atleast be one variable or non-terminal in Right most of RHS.

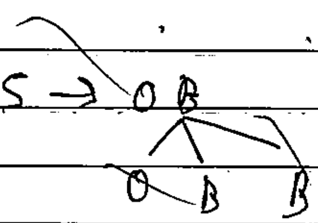
Ex: $A \rightarrow aB$



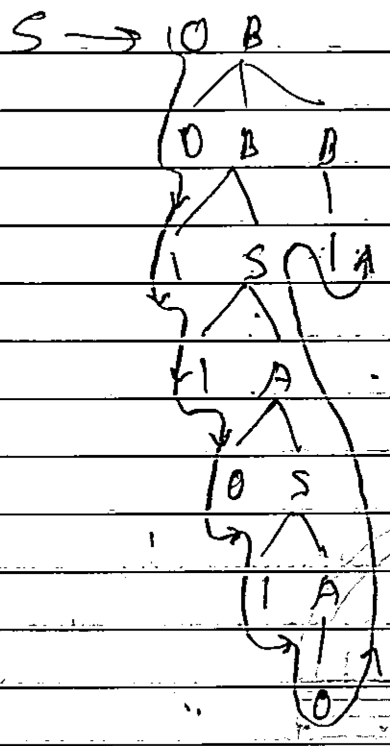
Sol. 3 d) Given: $S \rightarrow 0B \mid 1A$
$A \rightarrow 0 \mid 0S \mid 1AA$
$B \rightarrow 1 \mid 1S \mid 0BB$

For $w = 00110101$

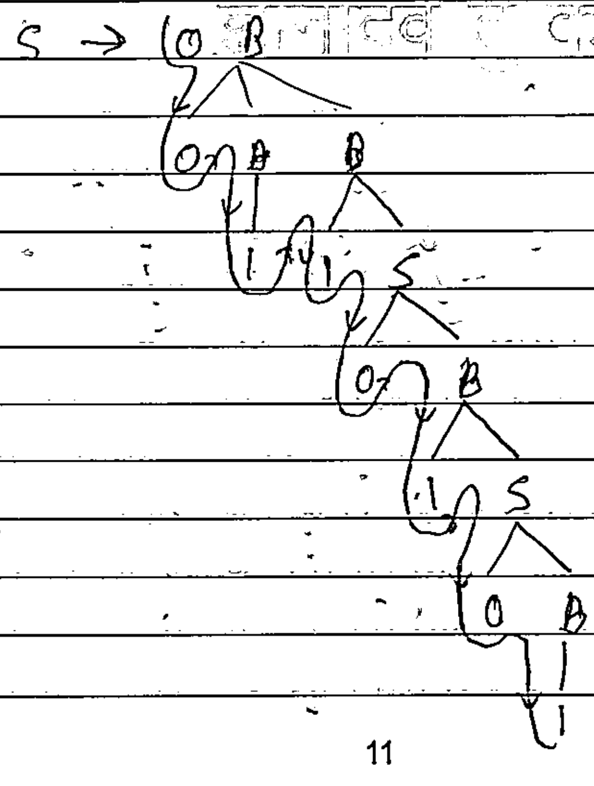
i) ~~LMDT~~ !

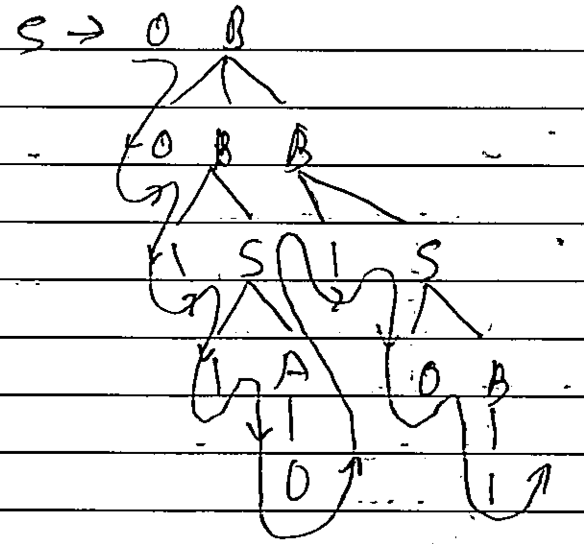


i) LMDT:



ii) RMDT:

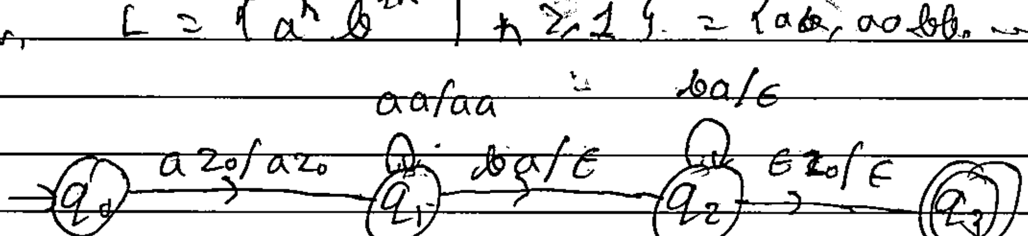




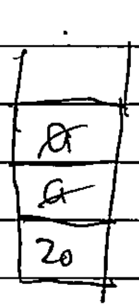
Sol. 4.a) NPDA or Non-Deterministic Push Down Automata is PDA in which there may be more than one transition for single input.

DPDA or Deterministic Push Down Automata is PDA in which there ~~may~~ must be only one transition for every single input.

Sol. 4.b) Given, $L = \{a^n b^{2n} \mid n \geq 1\} = \{ab, aabb, \dots\}$

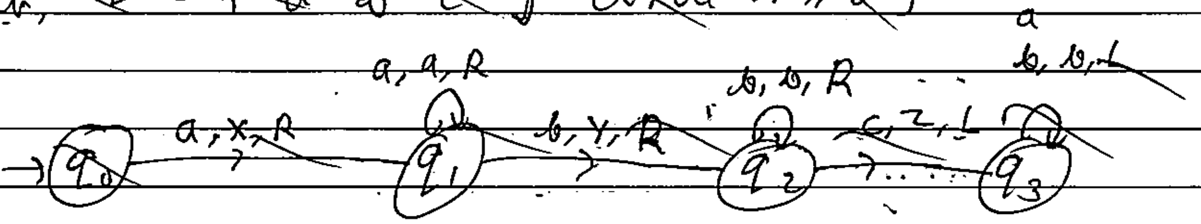


$L = \{aabb\}$



Transition:
i) $\delta(q_0, a, z_0) = (q_1, az_0)$
ii) $\delta(q_1, a, a) = (q_1, aa)$
iii) $\delta(q_1, b, a) = (q_2, \epsilon)$
iv) $\delta(q_2, b, a) = (q_2, \epsilon)$

~~Sol. 4) Given, L = {aⁿ bⁿ cⁿ} where n ≥ 0}~~

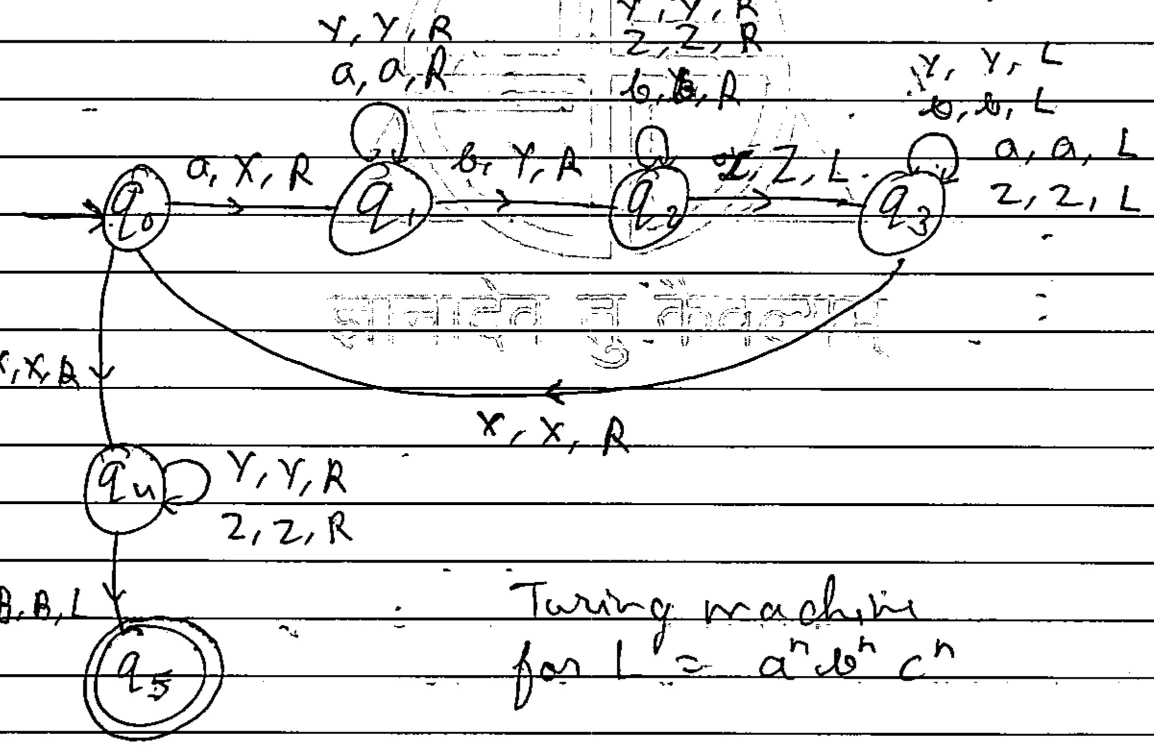


x) $\delta(q_2, \epsilon, z_0) = (q_3, \epsilon)$

Ans

Sol. 4) Given, $L = \{a^n b^n c^n$, where $n \geq 0\}$

Xa	Xa	Xa	Yb	bY	bY	Zc	Zc	cZ	B



Turing machine for $L = a^n b^n c^n$

Ans

Transitions:

$$\delta(q_0, a) = (q_1, X, R)$$
$$\delta(q_1, a) = (q_1, a, R)$$
$$\delta(q_1, Y) = (q_2, Y, R)$$
$$\delta(q_1, b) = (q_2, Y, R)$$
$$\delta(q_2, Y) = (q_2, Y, R)$$
$$\delta(q_2, b) = (q_2, b, R)$$
$$\delta(q_2, Z) = (q_2, Z, R)$$
$$\delta(q_2, c) = (q_3, Z, L)$$
$$\delta(q_3, a) = (q_3, a, L)$$
$$\delta(q_3, b) = (q_3, b, L)$$
$$\delta(q_3, Y) = (q_3, Y, L)$$
$$\delta(q_3, Z) = (q_3, Z, L)$$
$$\delta(q_3, X) = (q_0, X, R)$$
$$\delta(q_0, Y) = (q_4, X, R)$$
$$\delta(q_4, Y) = (q_4, Y, R)$$
$$\delta(q_4, Z) = (q_4, Z, R)$$
$$\delta(q_4, B) = (q_5, B, L)$$

Ans

Sol. 5a) Partial Functions are function which ~~no~~ mapping is available for some members.

Ex: Subtraction for Natural number.

~~If~~

Example: $5 - 6 = -1 \notin N$

$\therefore$ ~~How~~ $6 - 5 = 1 \in N$

So, it is partial Function.

- Initial function are predefined functions
- There are three types of Initial Function.

i) Zero Initial function: $Z(5) = 0$

ii) Successor function: $S(5) = 6$
or $S(x) = x+1$

iii) Projection function: $U \{x_1, x_2, x_3, x_4\}$

$U_2^4 = x_2$

Sol. 5.b) Given $f(x,y) = x * y$

$$\begin{aligned} f(x,y+1) &= x*(y+1) \\ &= x*y + y \\ &= f(x,y) + y \\ &= S^y(f(x,y)) \end{aligned}$$ [y times successor]

Since, it is determined by Successor Initial Function, thus, it is Primitive Recursive function.

Given, $f(x, y) = x^y$

$$f(x, y+1) = x^{y+1}$$
$$= x^y * x$$
$$= f(x, y) * x$$

Since, we know that multiplication is primitive recursive function.

$\therefore$ $f(x, y) = x^y$ is also primitive recursive function.

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