

Assignment # 2

22L-6446

BS CS 5E

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- $$\textcircled{1} \quad L = \{ w \mid w \text{ contains at least three } 1's \} \quad \Sigma = \{0, 1\}$$

$n_1(x) = 3$ or more

$$L = \{ \underline{\hspace{1cm}111}, \underline{\hspace{1cm}0111}, \underline{\hspace{1cm}1111}, \underline{\hspace{1cm}1011}, \underline{\hspace{1cm}1101}, \underline{\hspace{1cm}1110}, \dots \}$$

$S \rightarrow A \ 1 \ A \ 1 \ A \ 1$ 1 1 1
 $A \rightarrow 0A \mid 1A \mid \lambda$ $w_1 \quad w_2 \quad w_3 \quad w_4$
 $\downarrow \quad \downarrow$ $w_1, w_2, w_3, w_4 \in \Sigma^*$
 $0^+ \quad 1^+$

$$Ans: \quad S \rightarrow A_1 A_1 A_1$$

$$A \rightarrow OA | 1A | \wedge$$

- ② $\lambda = \{ w \mid \text{the length of } w \text{ is odd \& its middle symbol is } 0 \}$ $\Sigma = \{0, 1\}$

$\Rightarrow 0$ is an even number

$$L = \{0, 000, 101, 100, 001, 00000, \dots\}$$

$$\text{string} = \underline{\underline{1010100}}$$

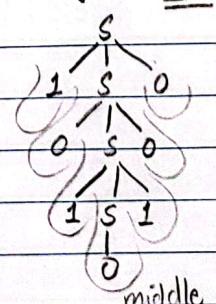
$$\text{Ans: } S \rightarrow 0$$

$\int \rightarrow \partial \delta \zeta$

$\delta \rightarrow 1$

$$s \rightarrow 0s1$$

$\delta \rightarrow 180$



$$n_{0a} = 0$$

$$\wedge n_{0b} = 0$$

$$n_0(w) > n_1(w)$$

③ $L = \{ w \mid w \text{ contains more } 0\text{'s than } 1\text{'s} \} \quad \Sigma = \{0, 1\}$

$$L = \{ 0, 00, 001, 000, 010, 100, 0000, \dots \} \\ \text{ss}(1) \quad s(1)s(1)ss$$

Ans $S \rightarrow 0S / S0 / SS1 / 1SS / S1S / 0$

④ $L = \{ 0^i 1^j \mid i \leq j \} \quad L = \{ 1, 11, 01, 111, 011, \dots \}$

$$0^i 1^j \quad | \quad 0^i 1^i$$

\downarrow Ans: $S \rightarrow A B | A$

$$(01)^*$$

$$A \rightarrow 0A1 | \wedge$$

$$B \rightarrow 1B | 1$$

OR

Ans: $S \rightarrow \wedge | 0S1 | S1$

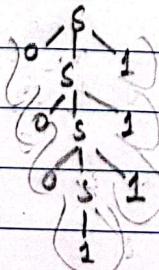
⑤ $L = \{ 0^i 1^j \mid i < 2j \}$

$$L = \{ 1, \frac{11}{s}, \frac{01}{s}, \frac{011}{s}, \frac{111}{s}, \frac{0011}{s}, \frac{0111}{s}, \frac{1111}{s} \}$$

$0 < 2^{(1)}$ Ans:

$$S \rightarrow 01 | 1 | S1 | 1S | 0S1$$

0001111



(2)

$$S \rightarrow A$$

$$A \rightarrow 1 | 01 | 0S1 | 1B$$

$$B \rightarrow 1 | 1B$$

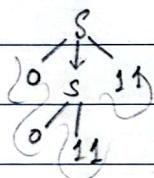
$$⑥ L = \{ 0^i 1^j \mid i, j \geq 0 \}$$

$i=1$	$j=2$	$i=0$
$i=2$	$j=4$	$j=2(0)=0$

$L = \{ 1, 01, 001111, 00011111, \dots \}$

$$i=2 \\ j=4 \\ L = \{ 001111 \}$$

Ans: $S \rightarrow 0S11 | \lambda$



$$⑦ L = \{ a^i b^j c^k \mid i, j, k \geq 0 \text{ & } i=j \text{ or } j=k \}$$

$$L = \{ 1, c, a, ab, bc, aa, cc, \dots \}$$

$a^0 b^0 c^1$	$a^1 b^0 c^0$
$a^0 b^0 c^1$	$a^0 b^1 c^0$
$a^1 b^1 c^0$	$a^0 b^1 c^1$
$a^1 b^0 c^1$	$a^1 b^1 c^1$
$i=0 \times$	$i=1 \times$

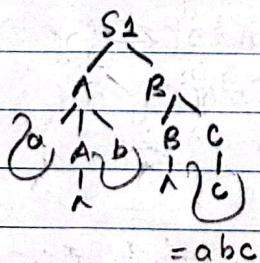
Ans:

abc

$$i, j, k \geq 0 \quad i=j=n \quad j=k=m$$

$\underbrace{a^n b^n c^k}$

$| \quad a^i \underbrace{b^m c^m}$



Ans:

$S_1 \rightarrow AB$

$S_2 \rightarrow CD$

$A \rightarrow aAb | \lambda$

$C \rightarrow Ca | \lambda$

$B \rightarrow Bc | \lambda$

$D \rightarrow bDc | \lambda$

$S \rightarrow S_1 | S_2$

$$⑧ \quad L = \{ a^i b^j c^k \mid i, j, k \geq 0 \text{ and } i+j=k \}$$

$$L = \{ \lambda, ac, bc, abcc, bbcc, aacc, \dots \}$$

$$a^\circ b^\circ c^\circ \quad 0+0=0$$

$$a^1 b^0 c^1 \quad 1+0=1$$

$$a^{\circ} b^1 c^1$$

$$ab^1c^2 \quad 1+1=2$$

$$a^{\circ} b^2 c^2$$

$$a^2 b^0 c^2$$

$$a^1 b^2 c^3$$

$$= \boxed{a \ b \ b \ c \ c \ c}$$

$$a^2 b^1 c^3$$

$$= \underline{aab}ccc$$

$$⑨ \quad L = \{ a^i b^j c^k \mid i, j, k \geq 0 \text{ & } i+k=j \}$$

$L = \{a, ab, bc, \overline{abb}c, \overline{bb}cc, \dots\}$

$aabb, abbbcc, \dots$

Ans: $S \rightarrow A B$

$$A \rightarrow aAb \mid \lambda$$

$$B \rightarrow b B c \bar{c} \Lambda$$

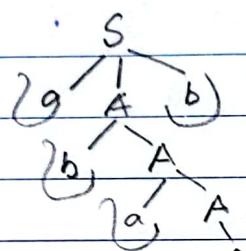
2

$$\begin{array}{c}
 a^6 b^2 c^2 \\
 a^2 b^2 c^0 \\
 a^1 b^3 c^2 \\
 a^2 b^3 c^1 \\
 \hline
 aabbcc
 \end{array}$$

(10) L is non palindrome language over $\{a, b\}$
 $abba \times abr \quad bar$

Ans: $S \rightarrow aSa | bSb | aAb | bAa$
 $A \rightarrow aA | bA | \lambda$

$abab$



for palindromes

$S \rightarrow aSb | bSa | b | a | \lambda$

(11) $L = \{w : w \text{ has twice as many } a's \text{ as } b's\}$

$L = \{\lambda, aab, aba, baa, \dots\}$

$a^i b^j \quad i=2j$

Ans: $S \rightarrow \lambda | aSaSb | aSbSa | bSaSa | S^8$

(12) $L = \{a^i b^j ; i=3j+2\}$ (dp) $a^2 b^0$

$L = \{aa, aaab, \dots\}$

$$3(0)+2 \\ = 0+2=2$$

$$a^2 b^1 \\ 3(1)+2 \\ 3+2=5$$

Ans: $S \rightarrow aa | aaaSb$

(13) $L = \{a^{2i} b^{3j} ; i, j \geq 0\}$ $a^{2(0)} b^{3(0)} = \lambda$

$L = \{\lambda, aa, bbb, \overline{aabbbb}, \dots\}$ $a^{2(0)} b^{3(1)} = aa$

$$a^{2(1)} b^{3(0)} = bbb$$

$$a^{2(1)} b^{3(1)} = aabb$$

Ans: $S \rightarrow AB$
 $A \rightarrow aaA | \lambda$
 $B \rightarrow bbbB | \lambda$

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

- (14) $L = \{ w \mid \text{length of } w \text{ is odd} \}$
 $L = \{ \underset{(0)(1)}{0}, \underset{(0)(1)}{1}, \underset{(0)(0)(0)}{000}, \underset{(0)(1)(0)}{001}, \underset{(0)(1)(1)}{101}, \underset{(0)(1)(0)}{100}, \dots \}$

Ans:

$$A \rightarrow 0A1 | 1A0 | 1A1 | 0 | 1 | 0A0$$

- (15) $L = \{ w \mid \text{length of } w \text{ is divisible by 3} \}$
 $\Sigma = \{0, 1\}$

$$0/3 \checkmark \quad L = \{ 1, \underset{000}{000}, 001, 010, 011, 101, 100, 111,$$

$$1/3 \quad \underset{000000, \dots}{\dots} \}, \text{ all combinations of } 3$$

$$2/3$$

$$3/3 \checkmark$$

$$4/3 \times$$

$$5/3 \times$$

$$6/3 \checkmark$$

$$0, 3, 6, 9, 12, \dots \quad A \rightarrow 000A | 001A | 010A | 011A | 101A$$

$$| 101A | 111A | \lambda$$

A B

- (16) $L = \{ (ab)^m | c^n d^n | (c)^m | m, n \geq 0 \}$

$$m, n \geq 1 \quad (ab)^i c^j d^j c^i \quad (ab)^i c^2 d^2 (c)^1$$

abc dc

abcc ddcc

$$L = \{ abcd, abccdd, \dots \}$$

$$(ab)^2 c^i d^i c^2$$

Ans:

$$abab cdcc$$

$$A \rightarrow cAd | cd$$

$$B \rightarrow abBc | abAc$$

- (17) $L = \{ \underbrace{(a^i b^i)^m}_A | \underbrace{(b^j a^j)^m}_B | i \geq 0, j \geq 0, m \geq 0 \}$

Ans:

$$A \rightarrow aAb | \lambda$$

$$S \rightarrow ASB | \lambda$$

$$B \rightarrow bBa | ba$$

$$(18) \quad L = \{ a^n b^m c^m \mid n, m \geq 2 \}$$

Ans:

$$S \rightarrow A C$$

$$A \rightarrow a A b \mid a a b b$$

$$C \rightarrow C c \mid c c$$

$$n=2 \quad m=2$$

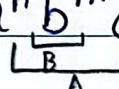
$$n=2 \quad m=3$$

aabbcc · aabbccc

$$n=3 \quad m=2$$

aaabbbcc

$$(19) \quad L = \{ a^n b^m c^n \mid n, m \geq 2 \}$$



Ans:

$$B \rightarrow b B \mid b b$$

$$A \rightarrow a A c \mid a a B c c$$

$$S \rightarrow A$$

$$n=2 \quad m=2$$

aabbcc

(20)

$$L = \{ a^n b^m \mid n+m = \text{even} \}$$

$$L = \{ \underset{\substack{\text{aa} \\ \text{S}}}{\text{a}}, \underset{\substack{\text{S}}}{\text{b}}, \underset{\substack{\text{aa} \\ \text{S}}}{\text{ab}}, \underset{\substack{\text{bb} \\ \text{S}}}{\text{aabb}}, \underset{\substack{\text{as} \\ \text{b}}}{\text{aab}}, \underset{\substack{\text{aa} \\ \text{S}}}{\text{agab}}, \underset{\substack{\text{bb} \\ \text{S}}}{\text{abbb}}, \dots \}$$

$$0+0=0 \text{ even}$$

$$0+2=2 \text{ even}$$

$$1+1=2 \text{ even}$$

$$3+1=4$$

$$2+1=3 \text{ odd}$$

$$1+3$$

$$2+2=4 \text{ even}$$

$$\text{Ans: } S \rightarrow \underset{\substack{\text{aa} \\ \text{S}}}{\text{a}} \mid \underset{\substack{\text{S}}}{\text{b}} \mid \underset{\substack{\text{aa} \\ \text{S}}}{\text{aSb}} \mid \underset{\substack{\text{S}}}{\text{aaS}} \mid \underset{\substack{\text{S}}}{\text{Sbb}}$$

(21)

$$L = \{ a^n b^m \mid n+m = \text{odd} \}$$

$$L = \{ \underset{\substack{\text{aa} \\ \text{S}}}{\text{a}}, \underset{\substack{\text{S}}}{\text{b}}, \underset{\substack{\text{aa} \\ \text{S}}}{\text{agb}}, \underset{\substack{\text{bb} \\ \text{S}}}{\text{gb}}, \dots \}$$

$$0+1=1 \text{ odd}$$

$$1+0$$

$$2+1=3$$

$$\text{Ans: } S \rightarrow \underset{\substack{\text{aa} \\ \text{S}}}{\text{a}} \mid \underset{\substack{\text{S}}}{\text{b}} \mid \underset{\substack{\text{aa} \\ \text{S}}}{\text{aas}} \mid \underset{\substack{\text{S}}}{\text{Sbb}}$$



HTML Table Creator

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$$\text{row} \cdot 1 \cdot 3 = 0$$

Numbers
only

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BSCS(5E)

else Number or Alphabet

0	2	4		$0 \cdot 1 \cdot 0 = 0$ (nos only)
1	A	5		{ numbers & alphabets
2	1	D		
3	8	9		$3 \cdot 1 \cdot 3 = 0$ (nos only)

each row → at least 1
Var no of cell or
cells column
 (1 or more)

<+8> <+8> row

$\langle td \rangle \langle /td \rangle$ cell or col

table → atleast 1 row (1 or more)

$\min \rightarrow$ 1 row 1 col

~~basecase <table>~~

<+r>
<+d> <\+d>

<1+1>

$\Rightarrow <\text{table}> \quad <\text{tr}> \quad <\text{th}> \quad <\text{td}>$, no, alpha $<\text{table}>$

Ans:

$S \rightarrow \langle \text{table} \rangle R \langle \backslash \text{table} \rangle$

$RS \rightarrow R_naR \mid R_nR$

$R \rightarrow R_n R \mid R_na R \mid \wedge$

6

$R_n \rightarrow \langle \text{row} \rangle C_n \langle \backslash \text{row} \rangle$

$C_n \rightarrow \langle \text{cell-no} \rangle C_n \mid \langle \text{cell no} \rangle$

$R_na \rightarrow \langle \text{row} \rangle C_na \langle \backslash \text{row} \rangle$

$C_na \rightarrow \langle \text{cell-no} \rangle C_na \mid \langle \text{cell-alpha} \rangle C_na \mid$
 $\langle \text{cell-no} \rangle \mid \langle \text{cell-alpha} \rangle$

$\langle \text{cell_no} \rangle \rightarrow \langle \text{td} \rangle \text{number} \langle \backslash \text{td} \rangle$

$\langle \text{cell-letter} \rangle \rightarrow \langle \text{td} \rangle \text{alphabet} \langle \backslash \text{td} \rangle$

Solution:

$S \rightarrow \langle \text{table} \rangle R \langle \backslash \text{table} \rangle$

$SR \rightarrow R^2_n R \mid R^3_na R$

$R_n \rightarrow \langle \text{tr} \rangle C_n^7 \langle \backslash \text{tr} \rangle$

$C_n \rightarrow \langle \text{colno} \rangle C_n^8 \mid \langle \text{colno} \rangle^9$

$R \rightarrow R^4_n R \mid R^5_na R \mid \wedge^6$

$R_na \rightarrow \langle \text{tr} \rangle C_na^{\text{10}} \langle \backslash \text{tr} \rangle$

$C_na \rightarrow \langle \text{colno} \rangle C_na^{\text{11}} \mid \langle \text{colalpha} \rangle C_na^{\text{12}}$
 $\langle \text{colno} \rangle^{\text{13}} \mid \langle \text{colalpha} \rangle^{\text{14}}$

$\langle \text{colno} \rangle \rightarrow \langle \text{td} \rangle \text{number}^{\text{15}} \langle \backslash \text{td} \rangle$

$\langle \text{colalpha} \rangle \rightarrow \langle \text{td} \rangle \text{alphabet}^{\text{16}} \langle \backslash \text{td} \rangle$

$\text{number} \rightarrow 0|2|3|4|5|6|7|8|9|10$

$\text{alphabet} \rightarrow A|B|C|D|E|F|G|H|I|J|K|L|M|N|O|P|Q|R|S|T|U|V|W|X|Y|Z$

both
same

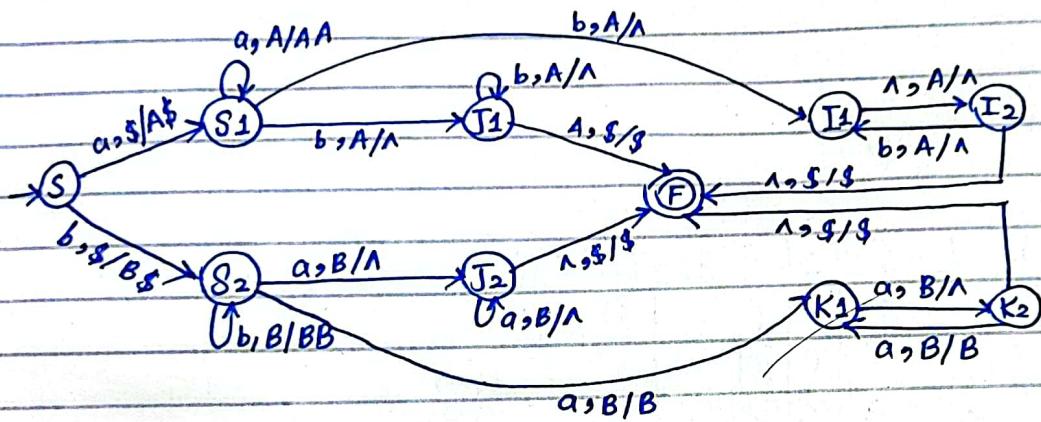
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Assignment: PDA

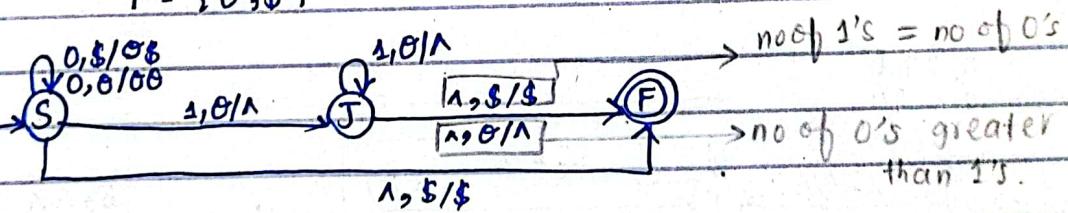
Extra Question:

$L = \{ w | w \text{ over } \{a, b\}, w \text{ has atleast equal number of } a's \text{ and } b's \text{ while at most twice } a's \text{ than } b's \}$



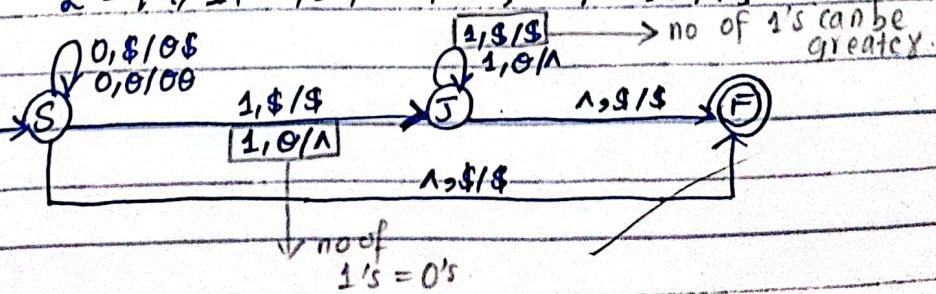
Q# 2: $L = \{ 0^i 1^j ; i \geq j \} \rightarrow i=j \quad i > j$
 $L = \{ 1, 0, 00, 01, 000, 001, \dots \}$

$\Gamma = \{ \theta, \$ \}$

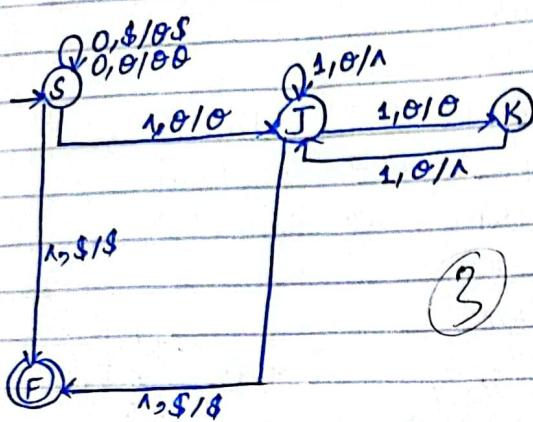


Q# 1: $L = \{ 0^i 1^j ; i \leq j \} \rightarrow i=j \quad i < j$
 $L = \{ 1, 1, 11, 01, 111, \dots \}$

$\Gamma = \{ \theta, \$ \}$



Q#3: $L = \{0^i 1^j ; i \leq j \leq 2i\}$
 $L = \{\lambda, 01, 011, 0011, 00111, \dots\}$



i	j	$2i$
0	0	0
1	<u>1</u> <u>2</u>	2
2	<u>2</u> <u>3</u> <u>4</u>	4
3	<u>3</u> <u>4</u> <u>5</u> <u>6</u>	6

$S \rightarrow \lambda | 0\$ 1| 0\$ 11$

max even no.

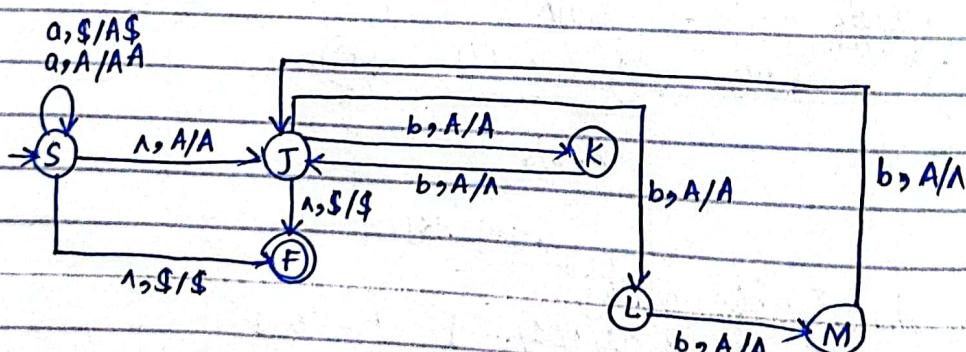
i	j	$2i$
0	0	0
0	1	1
0	1	0
1	0	0
1	1	1
1	1	1
1	1	1

Q#4: $L = \{0^i 1^j ; 2i \leq j \leq 3i\}$

$2i$	i	j	$3i$
0	0	<u>0</u>	0
2	1	<u>2</u> <u>3</u>	3
4	2	<u>4</u> <u>5</u> <u>6</u>	6
6	3	<u>6</u> <u>7</u> <u>8</u> <u>9</u>	9

even
and odd.

$S \rightarrow \lambda | aSbb | aSbbb$



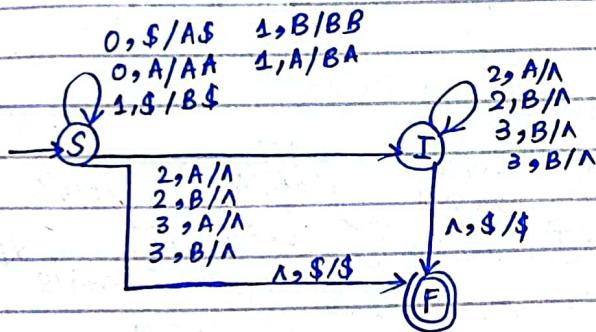
Q#6: $L = \{0^i 1^j$



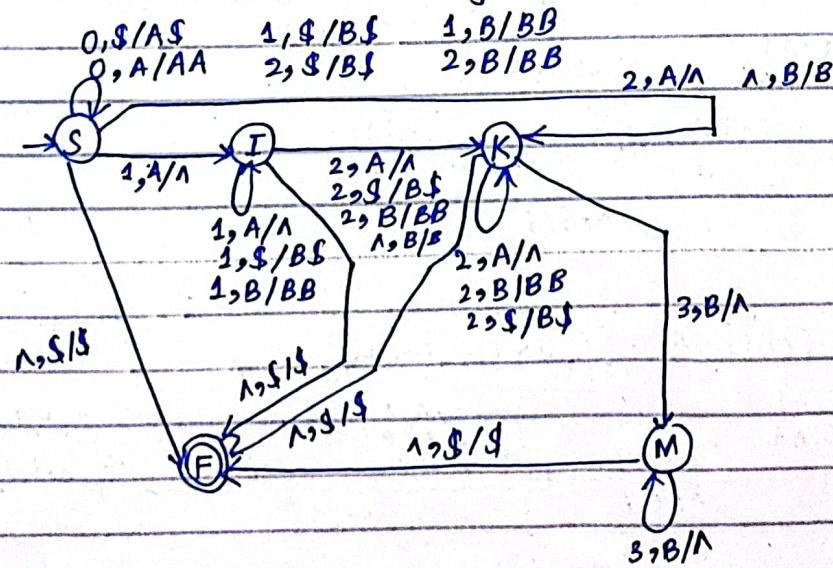
j 2i
 0 0
 1 2
 2 4
 3 4
 4 6
 5 6
 6 10
 10 11
 max even no.

Q#5: $L = \{0^i 1^j 2^k 3^l ; i+j=k+l\}$

i	j	k	l	
0	0	0	0	1
0	1	1	0	12
0	1	0	1	13
1	0	1	0	02
1	0	0	1	03
1	1	2	0	0122
1	1	0	2	0133
1	1	1	1	0123



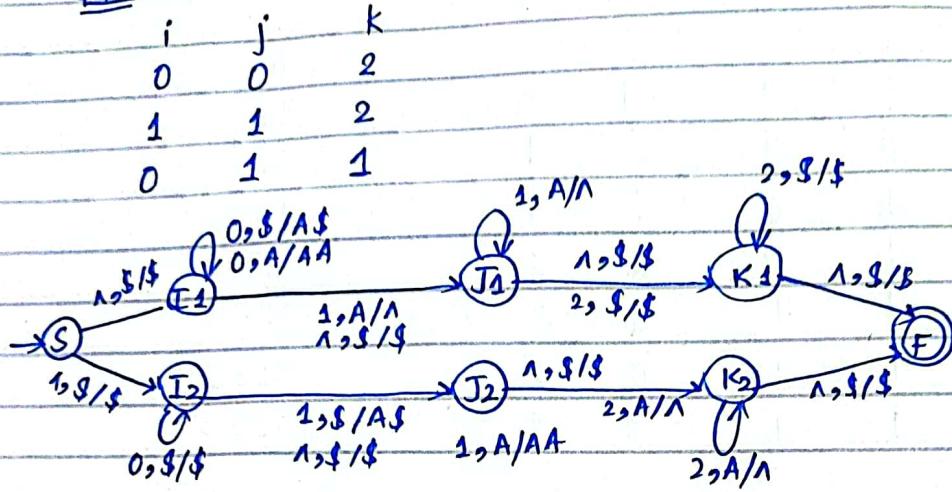
Q#6: $L = \{0^i 1^j 2^k 3^l ; i+l=j+k\}$



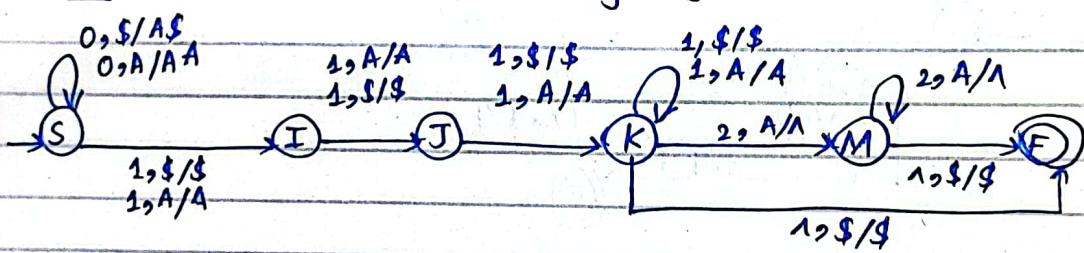
$\delta = \{ \text{W} \}$

Q#II

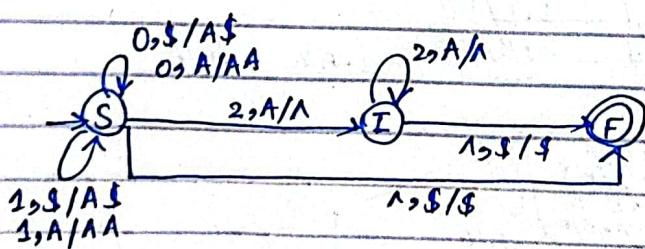
Q#7: $L = \{ 0^i 1^j 2^k \mid i, j, k \geq 0; i=j \text{ or } j=k \}$



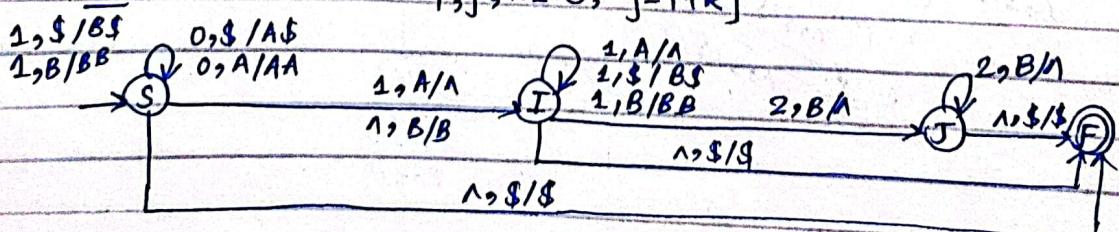
Q#8: $L = \{ 0^i 1^j 2^i \mid i \geq 0; j > 2 \}$



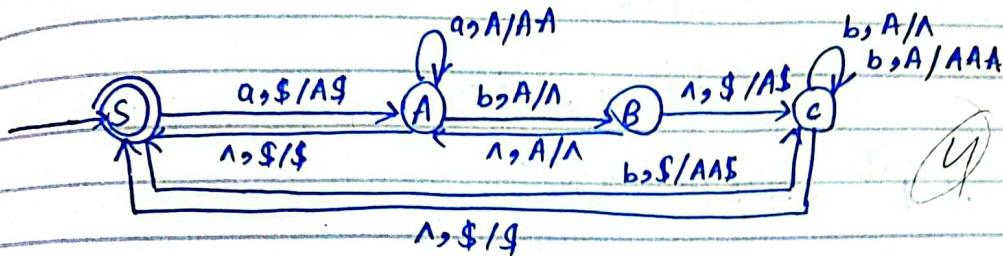
Q#9: $L = \{ 0^i 1^j 2^k \mid i, j, k \geq 0; k = i + j \}$



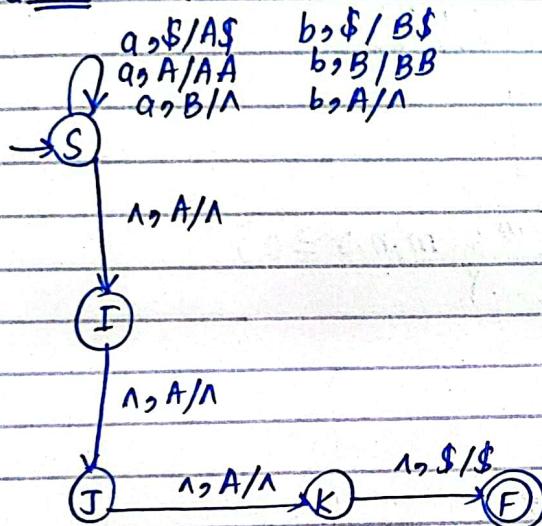
Q#10: $L = \{ 0^i 1^j 2^k \mid i, j, k \geq 0; j = i + k \}$



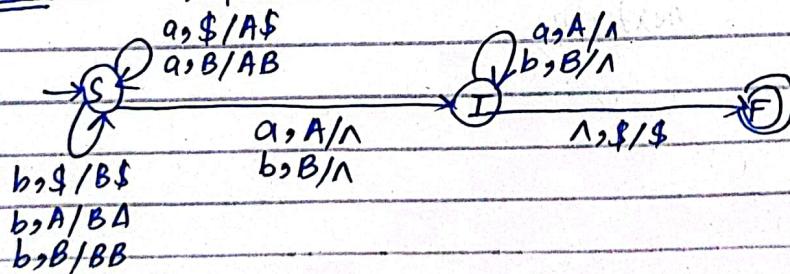
Q#11: $L = \{ w \mid w \text{ has twice } a's \text{ than } b's \}$



Q#12: $L = \{ w \mid w \text{ has three more } a's \text{ than } b's \}$



Q#13: $L = \{ w \mid w \text{ over } \{a, b\} \text{ & } w \text{ is even palindrome} \}$



Extra Q

M#2:

$a, \$ / A$

$a^2 A /$

$b, \$$

$b^2 B /$

$a, \$ /$

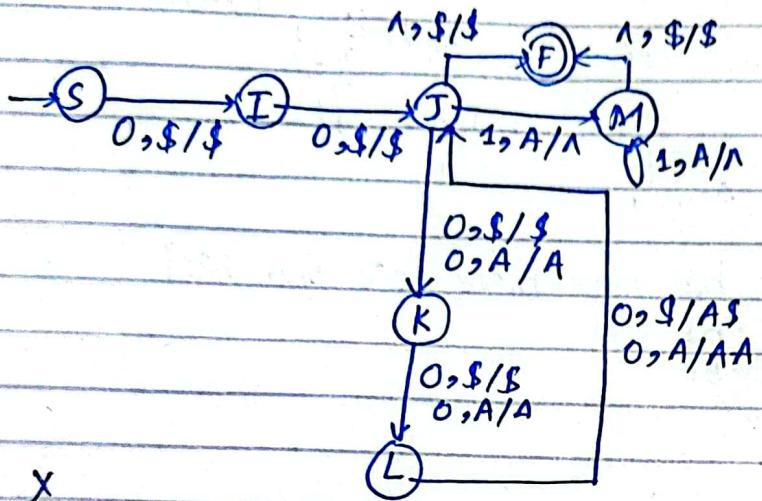
$a^2 A /$

$a, \$ /$

$a^2 A /$

Q#15:

$$L = \{ 0^i 1^j \mid i = 3j + 2 \}$$

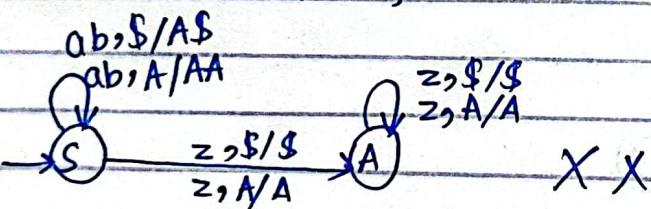


X

Q#16: $L = \{ (ab)^m z^{\gamma} c^n d^{\nu} e^{\mu} \mid m, n, \gamma, \nu \geq 0 \}$

$$L = \{ \lambda, cd, zzz, abe, \dots \}$$

$$\Gamma = \{ A, B, \$ \}$$



next page

Extra Question:

M#2:

