que = 1   Minimize the following   FAs

(1) ⇒ A, B, C, D, E, ∅   Accepting states
                                           = A, B, C, D, E

★ B	2				
★ C	3	2			
○ D	3	2			
○ E	3	2			
∅	1	1	1	1	1
	A	B	C	D	E

C, D, E
A
B
∅

$\delta(B, a) = \emptyset$ $\delta(C, a) = E$ $\delta(E, a) = E$
$\delta(A, a) = b$. $\delta(A, a) = b$. $\delta(D, a) = E$
                                                          $\delta(E, b) = D$
$\delta(B, b) =$ $\delta(C, b) = D$ $\delta(E, b) = D$.
$\delta(A, b) =$ $\delta(A, b) = D$

                                                          $\delta(E, a) = E$
$\delta(D, a) = E$ $\delta(E, a) = E$ $\delta(D, a) = E$
$\delta(A, a) = b$ $\delta(A, a) = b$ $\delta(E, b) = D$
                           $\delta(E, b) = D$ $\delta(D, b) = D$
$\delta(D, b) = D$ $\delta(A, b) = D$.
$\delta(A, b) = D$

$\delta(C, a) = E$ $\delta(D, a) = E$
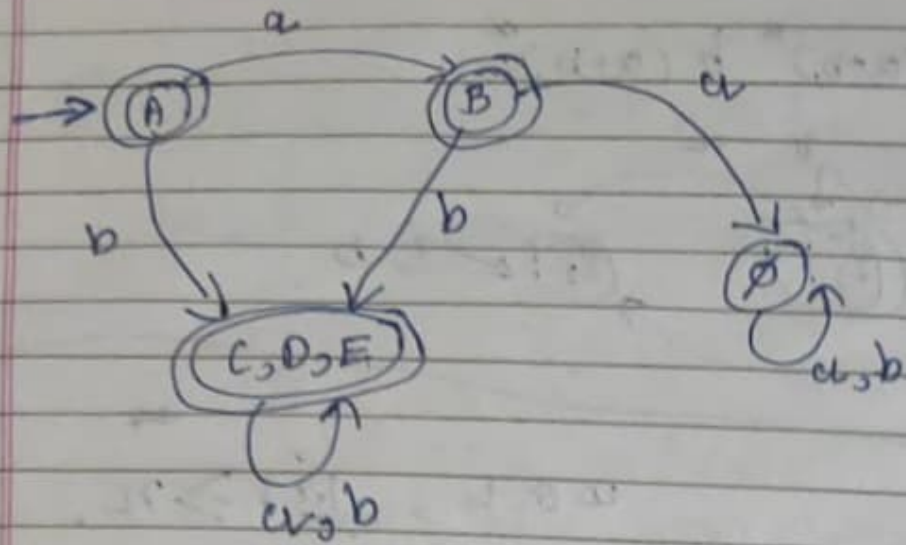$\delta(B, a) = \emptyset$ $\delta(B, a) = \emptyset$

$\delta(E, a) = E$ $\delta(D, a) = E$
$\delta(B, a) = \emptyset$ $\delta(C, a) = E$
                           $\delta(D, b) = D$
                           $\delta(C, b) = D$.

States: A (start, accepting), B (accepting), C,D,E (accepting), Ø

Transitions: A --a--> B, A --b--> C,D,E; B --b--> C,D,E, B --a--> Ø; Ø --a,b--> Ø; C,D,E --a,b--> C,D,E

(2)   1, 2, 3, 4, 5, 6, 7, 8.

2, 4, 6, 8.

	1						
* 2	1						
3		1					
* 4	1	2	1				
5	2	1	2	1			
* 6	1		1	2	1		
7	2	1	2	1		1	
* 8	1	8	1		1	2	1
	1	2	3	4	5	6	7
	*		*		*		

$\delta(5,4) = 8$
$\delta(7,4) = 8$
$\delta(3,b) = 5$
$\delta(7,b) = 4$
$\delta(6,4) = 3$
$\delta(8,a) = 7$
$\delta($

$\delta(3,4) = 6$
$\delta(7,a) = 8$
$\delta(3,b) = 5$
$\delta(7,b) = 4$

$\delta(4,4) = 1$
$\delta(6,4) = 7$

$\delta(4,4) = 1$
$\delta(8,4) = 3$

$\delta(4,b) = 5$
$\delta(8,b) = 7$

$\delta(1,a) = 2$
$\delta(3,4) = 6$
$\delta(1,b) = 7$
$\delta(3,b) = 5$

$\delta(1,4) = 2$
$\delta(7,4) = 8$
$\delta(1,b) = 7$
$\delta(7,b) = 4$

$\delta(2,a) = 5$
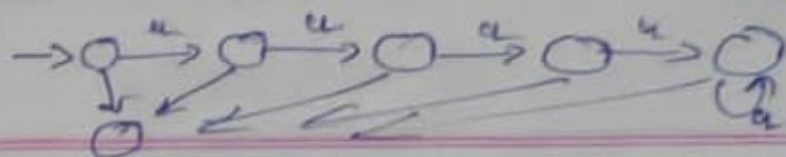$\delta(8,4) = 3$
$\delta(2,b) = 3$
$\delta(8,b) = 7$

$\delta(1,4) = 2$
$\delta(5,4) = 8$
$\delta(1,b) = 7$
$\delta(5,b) = 8$

$\delta(2,4) = 1$
$\delta(4,4) = 5$

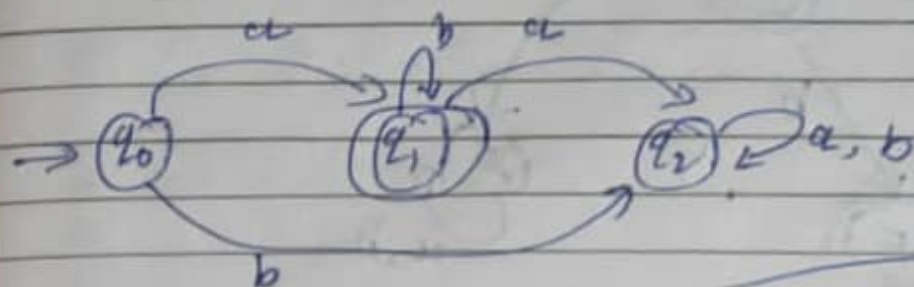$\delta(3,4) = 6$
$\delta(5,4) = 8$
$\delta(3,b) = 5$
$\delta(5,b) = 8$

$\delta(2,4) = 5$
$\delta(6,a) = 7$
$\delta(2,b) = 1$

$$(a+b)^* \ a \ (a+b)^* \ b \ (a+b)^*$$

Pumping Lemma

① $x = uvw$

$x \in L, \ |x| \geq n.$

① $|uv| \leq n$

② $|v| > 0$

③ for any $m \geq a, \ uv^m w \in L.$

$$x = 0^n \perp^n \qquad x \in L$$

$$|x| = 2n \geq n.$$

$$uv = 0^n$$

$$|uv| = n \leq n$$

$$uv = 0^{n-1} \ 0^1 \qquad |v| > 0 \qquad \rightsquigarrow \qquad u = 0^{n-1} \ v = 0^1$$

or

$$uv = 0^{n-2} \ 0^2 \qquad |v| > 0$$

Now, $uvw \in L \qquad uvw = 0^n \perp^n$

Now, $m = 2$

$$uv^m w = 0^{n \perp} (0^2)^m \ w$$

$$= 0^{n1} (0^1)^2 \ w$$

$$= 0^{n+1} \perp^n \ \notin L.$$

$\therefore$ prove Not Regular.

Tut-5

Que:- (2) $L = \{ xx \mid x \in \{0, 1\}^* \}$

$$|x| = (0\dot{1})(01)^n \qquad\qquad x = (01)^n$$
$$\qquad\qquad x = (1^n) \qquad n > 0$$

$uv = $

$$x = (01)^n$$

Now $xx = (01)^n (01)^n$

$|x| = xx = (01)^n (01)^n$

New $|x| = 4n \geqslant n$

Now $|x| = (01)^n (01)^n$

Now $uv = (01)^n$ $\qquad$ $uv = (01)^n$

~~prov b = 2n~~ $\qquad\qquad\qquad$ $2n$

$|x| = 0^n 1^n 0^n 1^n$

$uv = 0^n$ $\qquad\qquad w = 1^n 0^n 1^n$

$|uv| = n \leq n$

$\therefore u = 0^{n-1}$ $\quad v = 0$ $\qquad w = 1^n 0^n 1^n$

Now, $uvw \in L$

$uv^m w = (0^{n-1})(0)^m (1^n 0^n 1^n)$

$m = 2$

$= 0^{n-1} 0^2 (1^n 0^n 1^n)$

$= 0^{n+1} 1^n 0^n 1^n$

$= 0(01)^n (01)^n$

$= 0 (01)^n (01)^n$

$\qquad\qquad \notin L$.

$\therefore$ prove

(3) $L = \{ w w_r \mid w \in (a,b)^\infty$ and $|w| = 2 \}$

$\Rightarrow$ for some integer n.

$$w = (ab)^{\frac{n}{2}}$$
$$w = (ab)^n.$$

$n = 2$

$w = ab, aa, bb, ba$

$x = (ab)^n (ba)^n$

$|x| = 4n \geqslant n$

$x = a^n b^n b^n a^n$

Now $uv = a^n$

$|uv| = n \leq n.$

$u = a^{n-1} \quad v = a \quad w = b^n b^n a^n$

Now $uvw \in L$

$uv^m w = (a^{n-1})(a)^m (b^n b^n a^n) \quad m \geqslant 0$

Now $m = 2$.

$= a^{n-1} a^2 b^n b^n a^n.$

$= a \cdot a^n b^n b^n a^n.$

$= a (ab)^n (ba)^n.$

$\notin L.$

$\therefore$ prove
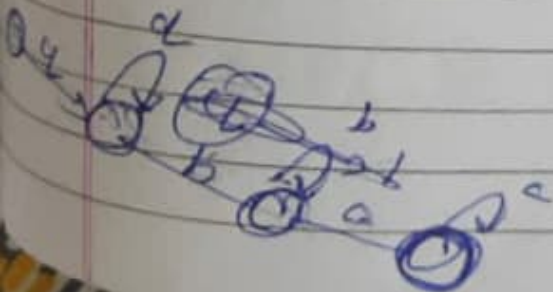
Tutorial - 6

Que-1 Design CFG.

(a) $\{a^i b^j c^k \,/\, i = j+k\}$

$\Rightarrow a^{(i)} b^j c^k$

$\Rightarrow a^{(j+k)} b^j c^k$

$\Rightarrow a^j b^j . a^k c^k$

$\Rightarrow (ab)^j (ac)^k$

$\quad\quad L_1 \quad\quad L_2$

$A \rightarrow aAb \,/\, \wedge$

$B \rightarrow aBc \,/\, \wedge$

$S \rightarrow AB$

(b) $\{a^i b^j c^k \,/\, j = i+k\}$

$\Rightarrow a^i b^{i+k} c^k$

$\Rightarrow a^i b^i . b^k c^k$

$\Rightarrow (ab)^i (bc)^k$

$A \rightarrow aAb \,/\, \wedge$

$B \rightarrow bBc \,/\, \wedge$

$S \rightarrow AB$

(c) $\{a^i b^j c^k \,/\, j = i \text{ or } j = k\}$

$j = i$

$\Rightarrow a^i b^i c^k$

$\Rightarrow (ab)^i c^k$

$A \rightarrow aAb/\wedge$

$B \rightarrow cB/\wedge$

$S_1 \rightarrow AB$

$S \rightarrow S_1/S_2$

$j = k$

$\Rightarrow a^i b^k c^k$

$\Rightarrow a^i (bc)^k$

$D \rightarrow aD/\wedge$

$E \rightarrow bEc/\wedge$

$S_2 \rightarrow DE$

$abcc$ ✓

$aabc$

$S \rightarrow S_1 | S_2$

$S_1 \rightarrow AB$

$S_2 \rightarrow DE$

$A \rightarrow aAb/\wedge$

$B \rightarrow CB/\wedge$

$D \rightarrow aD/\wedge$

$E \rightarrow bEc/\wedge$

$S \rightarrow S_2 \rightarrow DE$

$\rightarrow aD bEc$

aaA

$aAbCB$

$aAbCCB$

(4) $L = \{ a_n b_m c_k \mid n, m, k \geqslant 1 \}$

$\Rightarrow x = (a_n b_m c_k)^i$ $i > 0$.

$|x| = (n+m+k) i > i$

to $x = a_n b_m c_k$

Tb is Regular

(5)

(6)

(7)

(d) $\{a^i b^j c^k / i = j \text{ or } i = k\}$

B^+ 4

- CN   4
- DAA   4
- ML   4

$i = j$
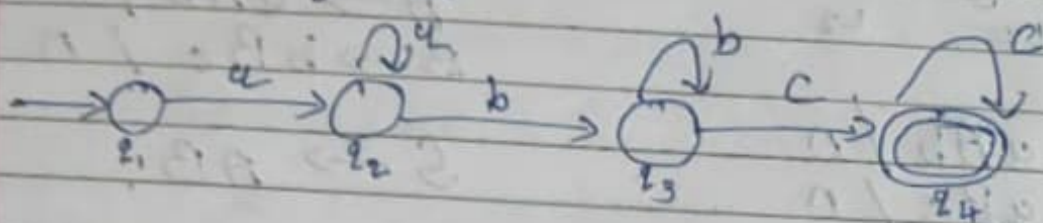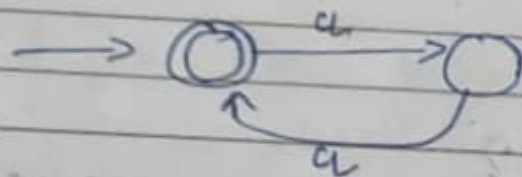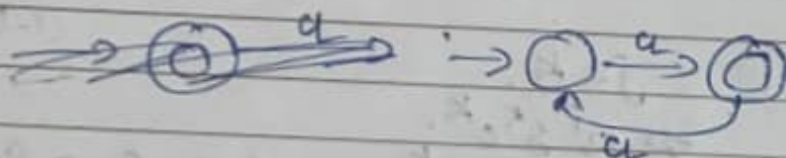
$\Rightarrow a^j b^j c^k$

$\Rightarrow (ab)^j c^k$

$A \rightarrow a A b / n$

$B \rightarrow c B / n$

$S_1 \rightarrow AB$

$i = k$

$\Rightarrow a^k b^j c^k$

$\Rightarrow \underbrace{\quad} \underbrace{\quad} \underbrace{\quad}$

$D \rightarrow a D / n$

$E \rightarrow b E / n$

$F \rightarrow c F / n$

$S_2 \rightarrow DEF$

$S \rightarrow S_1 / S_2$

(e) $\{a^i b^j c^k / i < j \text{ or } i > k\}$

$\Rightarrow$ if $j = i + m \quad m > 0$

$\Rightarrow a^i b^i b^m c^k$

$\Rightarrow (ab)^i b^m c^k$

$A \rightarrow a A b / n$

$B \rightarrow b B / n$

$D \rightarrow c D / n$

$S_1 \rightarrow ABD$

$i = k + n \quad n > 0$

$\Rightarrow a^k a^n b^j c^k$

$\Rightarrow$

$E \rightarrow a E / n$

$F \rightarrow a F / n$

$G \rightarrow b G / n$

$H \rightarrow c H / n$

$S_2 \rightarrow EFGH$

$S \rightarrow S_1 / S_2$