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Assignment No. 2

Q.1. Give regular expression for
a. Set of all strings over {0,1} that end with 1 has no substring 00
b. Set of all strings over {0,1} with even number's followed by an odd number.

⇒ Soln :-

a) Strings with end 1 and no substring '00'
⇒

$$R.E. = (0+1)^* (1+01)^*$$

$(0+1)^*$ ⇒ matches any no. of 0's and 1's
$(1+01)^*$ ⇒ allows for 1 or 01 to occur any no. of times, ensuring there's no substring '00' within the string.

b) Strings containing even no. followed by odd no.
⇒

$$R.E. = (01+10)^* 0$$

$(01+10)^*$ ⇒ Matches pairs of 01 or 10 any no. of times, representing an even no. of 1's.
(0) ⇒ ensures that string ends with an odd no. of 0's.

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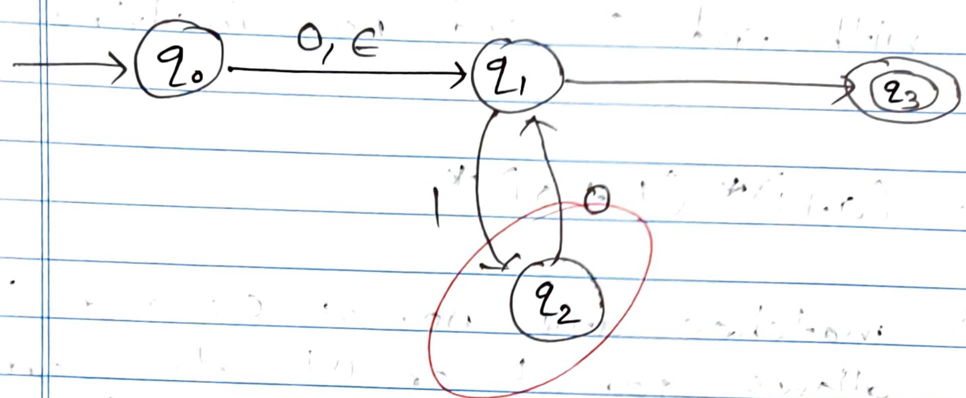
Q.2 Convert $(0+\epsilon)(10)^*(\epsilon+1)$ into NFA with ϵ-moves and hence obtain DFA.

⇒ Sol^n:-

Step I: NFA for the given expression

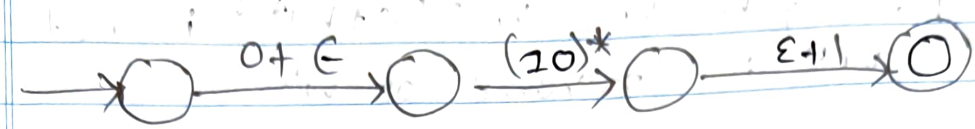


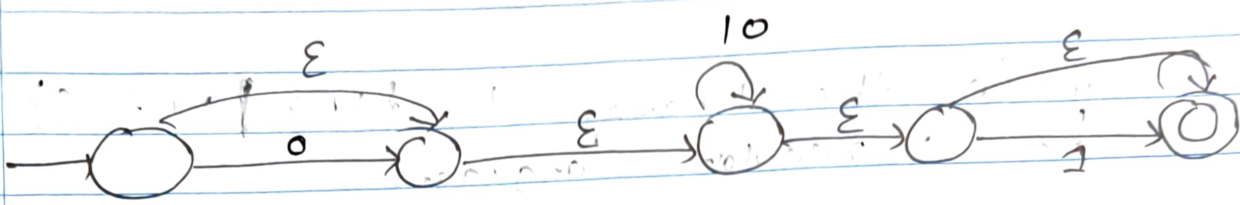
Step II: ϵ-closure of states

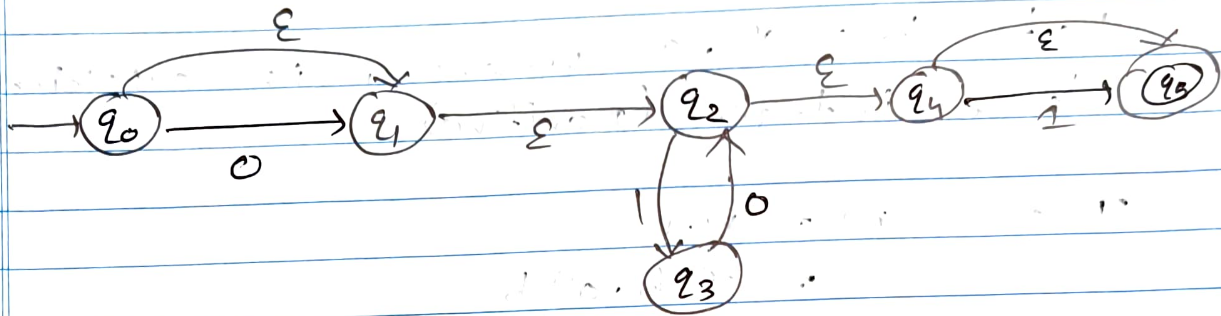
$q_0 \rightarrow \{q_0, q_1, q_3\}$
$q_1 \rightarrow \{q_1, q_3\}$
$q_2 \rightarrow \{q_2\}$
$q_3 \rightarrow \{q_3\}$

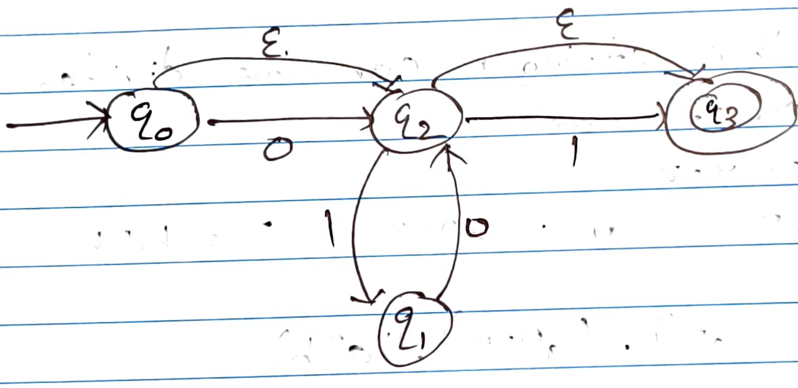
Step I in detail:
RE to NFA

⇒

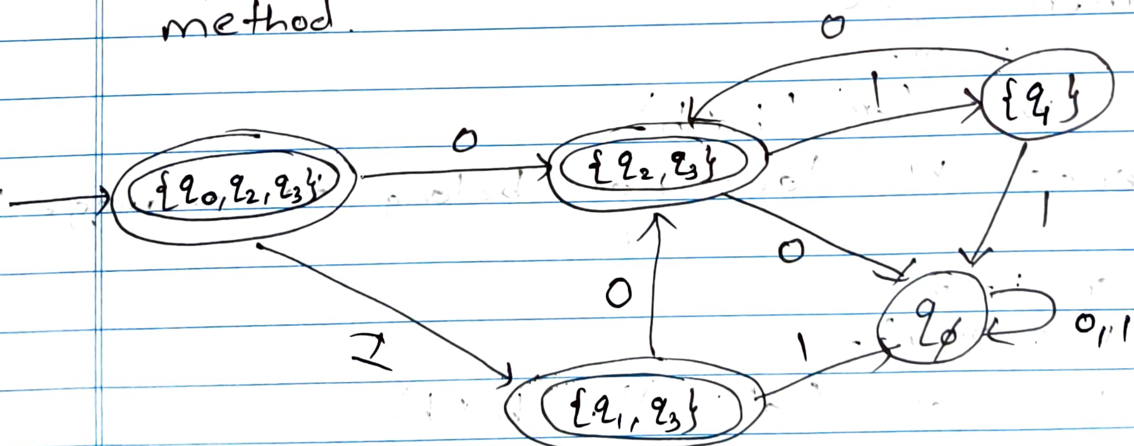








Step III: NFA to DFA using direct method.



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Q.3 Prove that $\{ W C W^R \mid W \in (a+b)^* \}$ is not regular where W^R is reverse of W^R.

⇒ <u>Solⁿ :-</u>

Consider the language $L = \{ W, W \mid W \in C \}$ be a regular language.

Let $w = a^n . a$ where n is sufficient large integer (positive).

Then $m = w . w$
$= a^n . b . a^n b$

<u>Case 1:</u> The string n, can be divided into three parts as

$m = x . y . z$

$x = a^m$, $y = a^{n-m}$, $z = ba^nb$

Hence,

$w = (a^m) . (a^{n-m}) . (ba^nb)$

∴ By pumping lemma $w = xyz$ where $i >= 0$

when $i = 0$

$w = x . z$

$w = (a^m)(ba^nb)$

Hence w does not belong to language L

when $i = 2$

$w = x \; y^2 z$

∴ $w = a^m \; (a^{n-m})^2 . (ba^nb)$

$W = (a^m)\ (a^{2n-2m})\ (b\ a^n b)$
$= a^{2n-m} \cdot b \cdot a^n b$
$\therefore$ w does not belong to language L

Case II :

$w = x \cdot y \cdot z$
let $x = a^n$, $y = 1$, & $z = a^n b$

Hence $w = (a^n)(b)(a^n b)$

By pumming lemma, $w = x y^i z$, where $i >= 0$
when $i = 0$
$w = x \cdot z$
$w = a^n \cdot (a^n b)$
Hence w does not belong to language L

when $i = 2$
$w = x y^2 z$
$= a^n (b)^2 (a^n b)$
$= a^n b^2 a^n b$

Hence w does not belong to L.
$\therefore$ From case I and II, we can say language L is regular is not true.

$\therefore$ Given language L is not a regular language.

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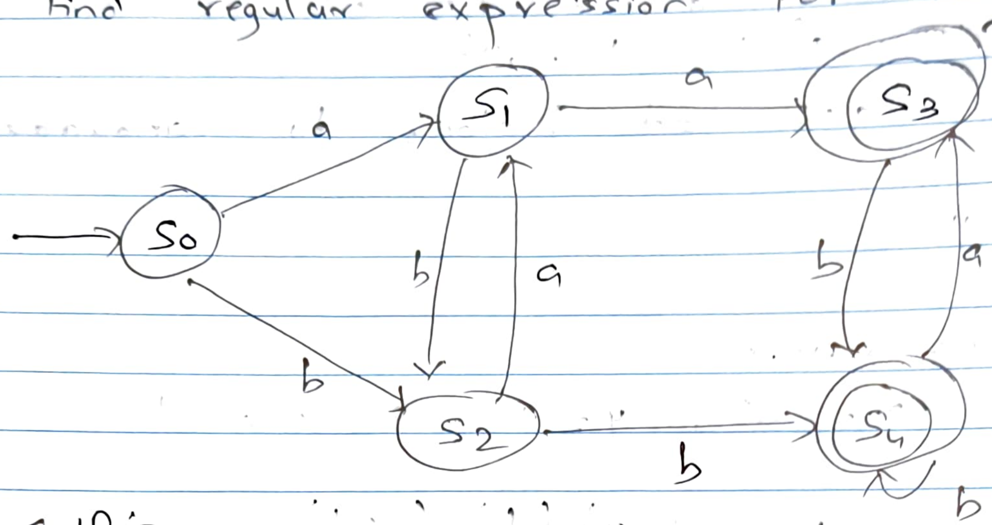
Q.4 Find regular expression for following FA



⇒ Soln :-

Equations can be written as:

$$S_0 = \varepsilon \quad -(1)$$
$$S_1 = S_0 . a + S_2 . a \quad -(2)$$
$$S_2 = S_0 . b + S_1 . b \quad -(3)$$
$$S_3 = S_1 . a + S_4 . a + S_3 . a \quad -(4)$$
$$S_4 = S_2 . b + S_4 . b + S_3 . b \quad -(5)$$

Putting $S_0 = \varepsilon$ in eq (1) and (2) we get

$$S_1 = \varepsilon . a + S_2 . a = S_2 . a + \varepsilon . a \quad -(6)$$
$$S_2 = \varepsilon . b + S_1 . b = S_1 . b + \varepsilon . b \quad -(7)$$

- Given DFA can be described as -

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

where

$Q = \{s_0, s_1, s_2, s_3, s_4\}$

$\Sigma = \{a, b\}$

$q_0 = \{s_0\}$

$F = \{s_3, s_4\}$

- Transition function can be written as -

$\delta(s_0, a) = s_1$, $\delta(s_0, b) = s_2$

$\delta(s_1, a) = s_3$, $\delta(s_1, b) = s_2$

$\delta(s_2, a) = s_1$, $\delta(s_2, b) = s_4$

$\delta(s_3, a) = s_3$, $\delta(s_3, b) = s_4$

$\delta(s_4, a) = s_3$, $\delta(s_4, b) = s_4$

- Grammar can be mapped as $G(V, T, S, P)$

$V = \{s_0, s_1, s_2, s_3, s_4\}$

$T = \{a, b\}$

$S = s_0$

- Production rules can be written as -

$s_0 \to a s_1$ $s_0 \to b s_2$

$s_1 \to a$ $s_1 \to b s_2$

$s_2 \to a s_1$ $s_2 \to b$

$s_3 \to a$ $s_3 \to b$

$s_4 \to a$ $s_4 \to b$

∴ Final Production rules :-

$$S_0 \rightarrow aS_1 \mid bS_2$$
$$S_1 \rightarrow a \mid bS_2$$
$$S_2 \rightarrow aS_1 \mid b$$
$$S_3 \rightarrow a \mid b$$
$$S_4 \rightarrow a \mid b$$