

(1)

$$S \rightarrow (A) | a$$

$$A \rightarrow A, S | S$$

Ans:

$$S \rightarrow (A) | a$$

$$A \rightarrow SA'$$

$$A' \rightarrow , SA' | \epsilon$$

(2)

$$S \rightarrow Ad$$

$$A \rightarrow Bb \mid cD$$

$$B \rightarrow (B) \mid a \mid \epsilon$$

$$c \rightarrow bCc \mid \epsilon$$

$$D \rightarrow cBc \mid B$$

Ans:

$$\text{FIRST}(S) = \{ \epsilon, a, b, c, d \}$$

$$\text{FIRST}(A) = \{ \epsilon, a, b, c, \epsilon \}$$

$$\text{FIRST}(B) = \{ \epsilon, a, \epsilon \}$$

$$\text{FIRST}(c) = \{ b, \epsilon \}$$

$$\text{FIRST}(D) = \{ \epsilon, a, c, \epsilon \}$$

(3)

2, 1, 2, 3. { 2 }

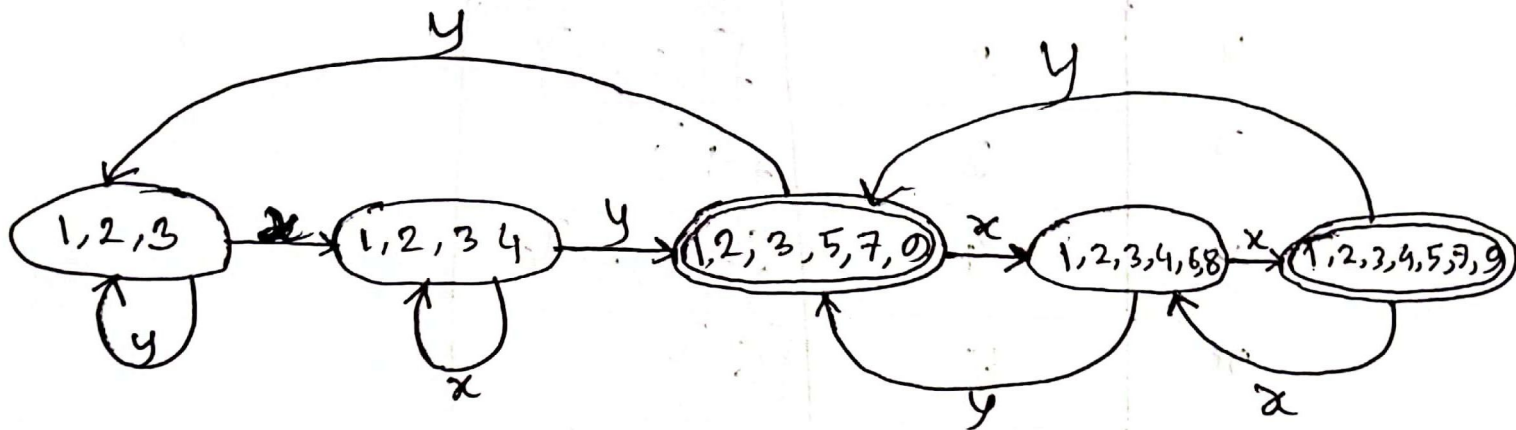


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|   | Node | Followpos         |
|---|------|-------------------|
| x | 1    | {1,2,3}           |
| y | 2    | {1,2,3}           |
| x | 3    | {4}               |
| y | 4    | {5,7,9}           |
| x | 5    | {6}               |
| y | 6    | {5,7,9}           |
| x | 7    | { <del>5</del> 8} |
| x | 8    | {5,7,9}           |
| # | 9    | {}                |

| Dstates                      | x              | y |
|------------------------------|----------------|---|
| $\{1,2,3\} \equiv A$         | B              | A |
| $\{1,2,3,4\} \equiv B$       | B              | C |
| $\{1,2,3,5,7,9\} \equiv C$   | <del>B</del> D | A |
| $\{1,2,3,4,6,8\} \equiv D$   | E              | C |
| $\{1,2,3,4,5,7,9\} \equiv E$ | D              | C |

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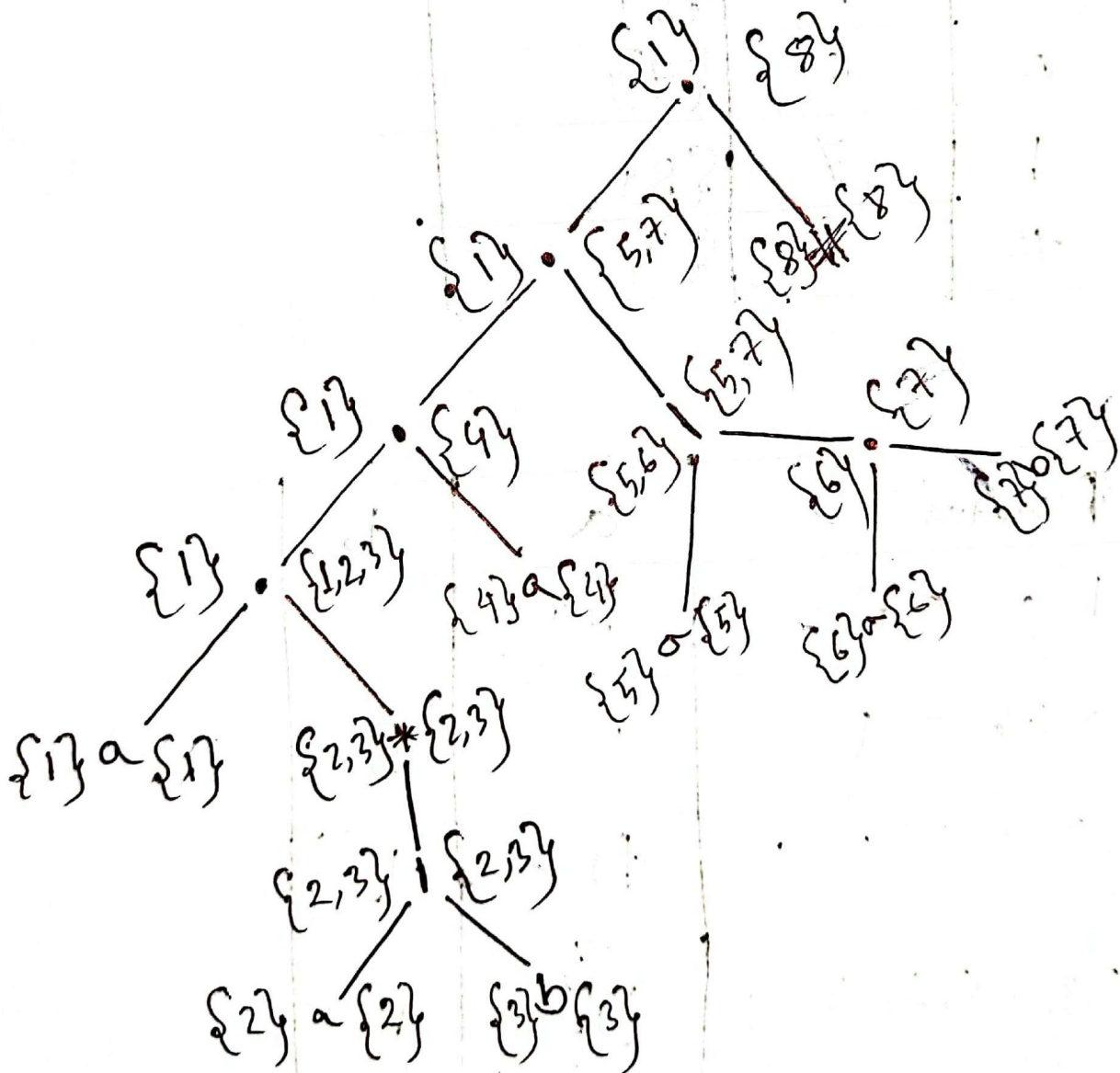
DFA for  $(xy)^* xy (xy | xx)^* \#$



(4)

$$a(a|b)^* a(a|ab)^{\#}$$

1 2 3 4 5 6 7 8

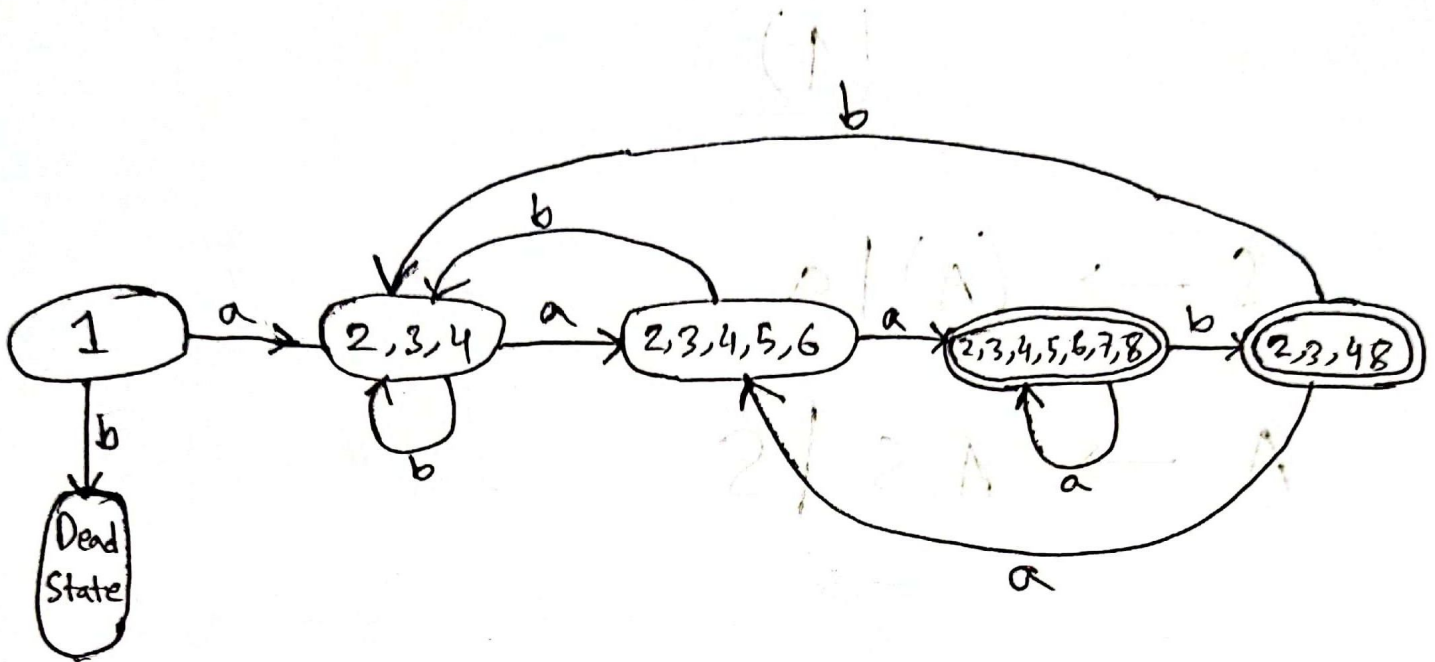


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|   | Node | Followups |
|---|------|-----------|
| a | 1    | {2, 3, 4} |
| a | 2    | {2, 3, 4} |
| b | 3    | {2, 3, 4} |
| a | 4    | {5, 6}    |
| a | 5    | {8}       |
| a | 6    | {7}       |
| b | 7    | {8}       |
| # | 8    | {}        |

| Dstates                          | a | b |
|----------------------------------|---|---|
| {1} $\equiv A$                   | B |   |
| {2, 3, 4} $\equiv B$             | C | B |
| {2, 3, 4, 5, 6} $\equiv C$       | D | B |
| {2, 3, 4, 5, 6, 7, 8} $\equiv D$ | D | E |
| {2, 3, 4, 8} $\equiv E$          | C | B |

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DFA for  $a(a|b)^*a(a|ab)\#$