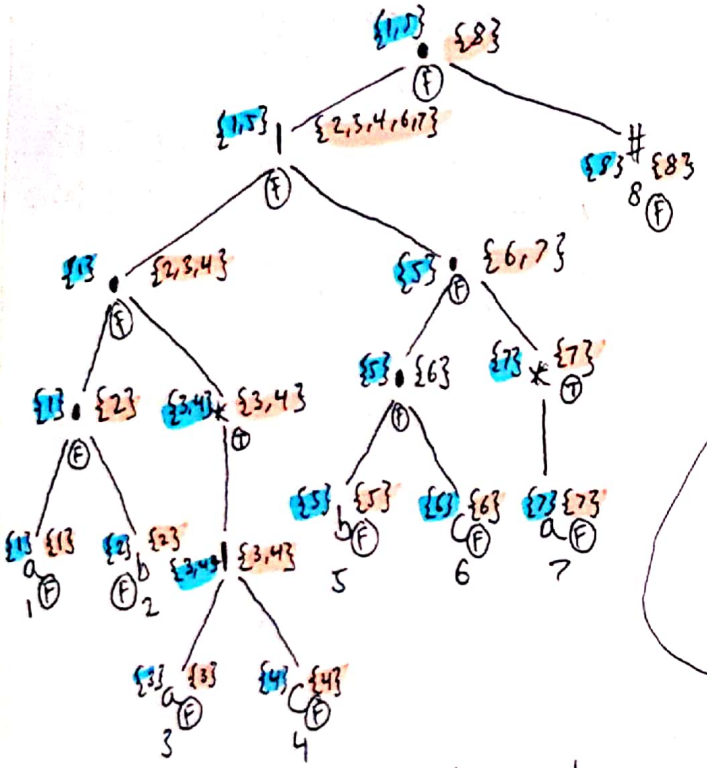
# Exercise

1. a) construct tree  a b (a|c)* | b c (a)* #
   1 2 3 4 5 6 7 8



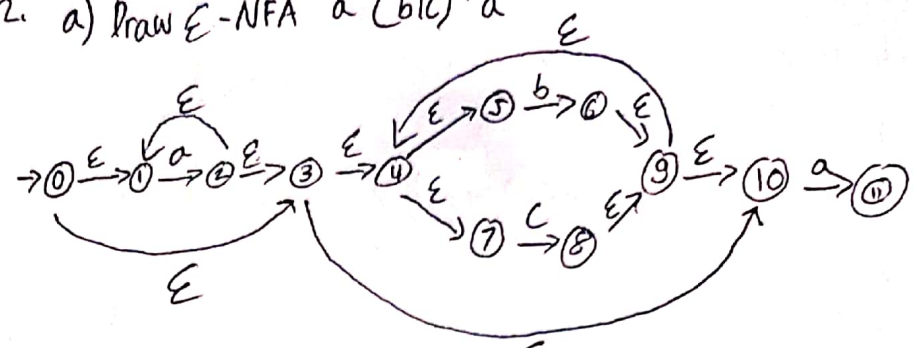
b)

| Node | followpos |
|---|---|
| 1 | {2} |
| 2 | {3,4,8} |
| 3 | {3,4,8} |
| 4 | {3,4,8} |
| 5 | {6} |
| 6 | {7,8} |
| 7 | {7,8} |
| 8 | - |

c)

| State | a | b | c |
|---|---|---|---|
| →{1,5} | fp{1}={2} | fp{5}={6} | |
| {2} | | fp{2}={3,4,8} | |
| {6} | | | fp{6}={7,8} |
| *{3,4,8} | fp{3}={3,4,8} | | fp{4}={3,4,8} |
| *{7,8} | fp{7}={7,8} | | |

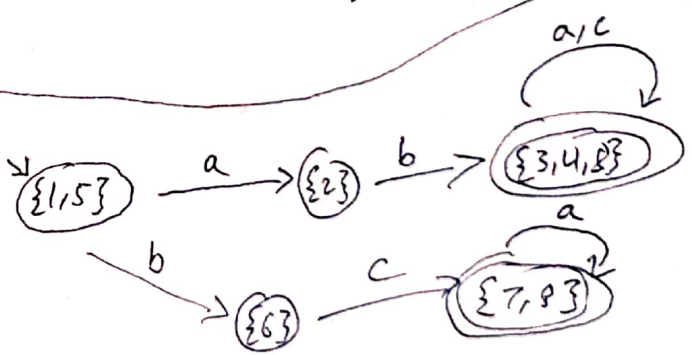
2. a) Draw ε-NFA a*(b|c)*a



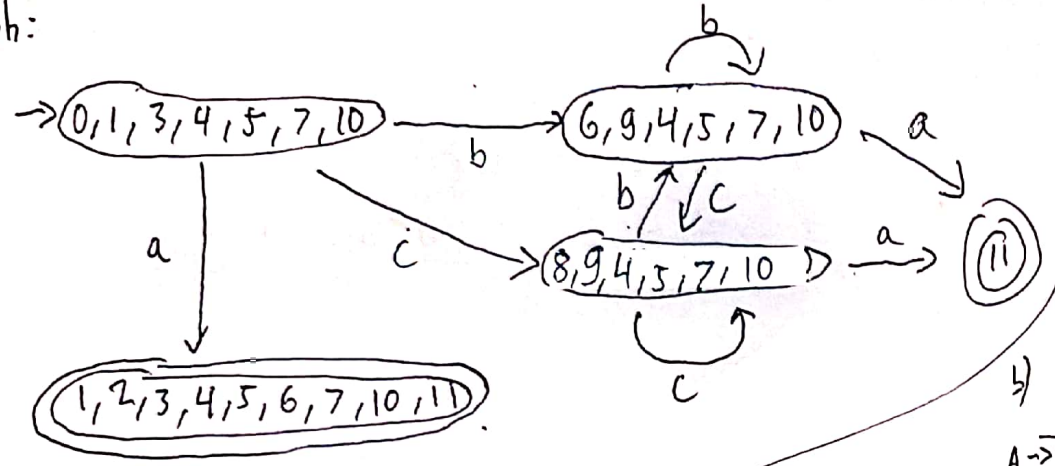
b)

| State | a | b | c |
|---|---|---|---|
| →{0}={0,1,3,4,5,7,10} | {2,11}={1,2,3,4,5,7,10,11} | {6}={6,9,4,5,7,10} | {8}={8,9,4,5,7,10} |
| {1,2,3,4,5,7,10,11}= *{1,2,3,4,5,7,10,11} | {2,11}={1,2,3,4,5,7,10,11} | {6}={6,9,4,5,7,10} | {8}={8,9,4,5,7,10} |
| {6,9,4,5,7,10}= {6,9,4,5,7,10} | {11}={11} | {6}={6,9,4,5,7,10} | {8}={8,9,4,5,7,10} |
| {8,9,4,5,7,10}= {8,9,4,5,7,10} | {11}={11} | {6}={6,9,4,5,7,10} | {8}={8,9,4,5,7,10} |
| {11}=*{11} | — | — | — |

Graph →



Graph:




c) $S \to aAB$

$A \to aA \mid \varepsilon$

$B \to BC \mid \varepsilon$

$C \to b \mid c$

4. $A \to B\text{-}A \mid B$

$B \to num \mid num * B \mid [A]$

a) $A \to B\text{-}A \mid B$ $\quad B \to num \mid num * B \mid [A]$

$A \to B(\underbrace{\text{-}A}_{A'} \mid \varepsilon)$ $\quad B \to num(\underbrace{\varepsilon \mid *B}_{B'}) \mid [A]$

b)

| | First | Follow |
|---|---|---|
| $A \to BA'$ | num, [ | $, ] |
| $A' \to -A \mid \varepsilon$ | -, $\varepsilon$ | $, ] |
| $B \to numB' \mid [A]$ | num, [ | $, -, ] |
| $B' \to \varepsilon \mid *B$ | $\varepsilon$, * | $, -, ] |

| | - | num | * | [ | ] | $ |
|---|---|---|---|---|---|---|
| A | | $A \to BA'$ | | $A \to BA'$ | | |
| A' | $A' \to -A$ | | | | $A' \to \varepsilon$ | $A' \to \varepsilon$ |
| B | | $B \to numB'$ | | $B \to [A]$ | | |
| B' | $B' \to \varepsilon$ | | $B' \to *B$ | | $B' \to \varepsilon$ | $B' \to \varepsilon$ |

Validation [num*num] →

3.

| Group | state | a | b |
|---|---|---|---|
| G1 | → Q0 | Q1 (G1) | Q2 (G1) |
| | Q1 | Q1 (G1) | Q4 (G2) |
| | Q2 | Q1 (G1) | Q2 (G1) |
| | Q3 | Q2 (G1) | Q4 (G2) |
| G2 | * Q4 | Q1 (G1) | Q2 (G1) |

| Group | state | a | b |
|---|---|---|---|
| G1 | → Q0 | $Q_1$ (G2) | $Q_2$ (G1) |
| | Q2 | $Q_1$ (G2) | $Q_2$ (G1) |
| G2 | Q1 | $Q_1$ (G2) | $Q_4$ ($G_3$) |
| | Q3 | $Q_2$ (G1) | $Q_4$ ($G_3$) |
| G3 | * Q4 | $Q_1$ ($G_2$) | $Q_2$ (G1) |

| Group | state | a | b |
|---|---|---|---|
| G1 | → Q0 | $Q_1$ (G2) | $Q_2$ (G1) |
| | Q2 | $Q_1$ (G2) | $Q_2$ (G1) |
| G2 | Q1 | $Q_1$ ($G_2$) | $Q_4$ ($G_4$) |
| G3 | Q3 | $Q_2$ (G1) | $Q_4$ ($G_4$) |
| G4 | * Q4 | $Q_1$ ($G_2$) | $Q_2$ (G1) |

C.

| Stack | Input Buffer | Action |
|---|---|---|
| A$ | [num * num]$ | A → B A' |
| B A'$ | [num * num]$ | B → [A] |
| [A] A'$ | [num * num]$ | pop [ |
| A] A'$ | num * num]$ | A → B A' |
| B A'] A'$ | num * num]$ | B → num B' |
| num B' A'] A'$ | num * num]$ | Pop num |
| B' A'] A'$ | * num]$ | B' → * B |
| * B A'] A'$ | * num]$ | Pop * |
| B A'] A'$ | num]$ | B → num B' |
| num B' A'] A'$ | num]$ | Pop num |
| B' A'] A'$ | ]$ | B' → ε |
| A'] A'$ | ]$ | A' → ε |
| ] A'$ | ]$ | Pop ] |
| A'$ | $ | A' → ε |
| $ | $ | Accepted |