

## REGULAR EXPRESSIONS, NFA AND DFA's

### Integers:

Integer Constant is a sequence of one or more digits.

Integer :-

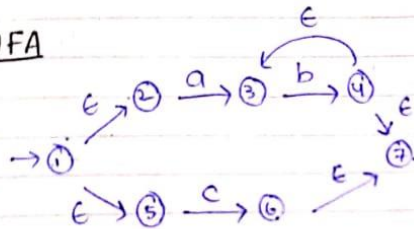
RE :-  $[1-9][0-9]^*|0$

$a = [1-9]$

$b = [0-9]$

$c = 0$

NFA



E-closure :-

$E\text{-closure}(1) = \{1, 2, 5\} \rightarrow (A)$

$E\text{-closure}(2) = \{2\}$

$(3) = \{3\}$

$(4) = \{3, 4, 7\}$

$(5) = \{5\}$

$(6) = \{6, 7\}$

$(7) = \{7\}$

Move :-

$E(M(A, a)) = \{1, 2, 5\} \xrightarrow{a} E\text{-closure}(3) = \{3\} (B)$

$M(A, b) = \emptyset$

$M(A, c) = \{1, 2, 5\} \xrightarrow{c} E(6) = \{6, 7\} (C)$

$M(B, a) = \{3\} \xrightarrow{a} \emptyset$

$M(B, b) = \{3\} \xrightarrow{b} E(4) = \{3, 4, 7\} (D)$

$$M(C, a) = \{ \emptyset \}$$

$$(C, b) = \emptyset$$

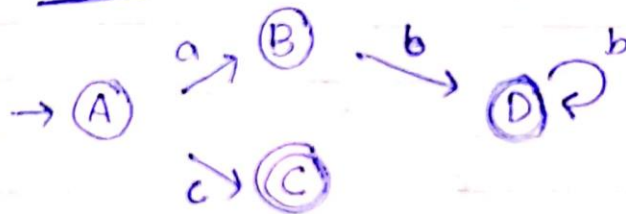
$$(C, c) = \emptyset$$

$$M(D, a) = \{ \emptyset, \emptyset, \emptyset \} = \emptyset$$

$$M(D, b) = \{ \emptyset, \emptyset, \emptyset \} = \epsilon(u) \quad (D)$$

$$M(D, c) = \emptyset$$

DFA



## Identifiers:

Identifier is any name given to the element in program, to a variable, function name or class name etc. The name can range from 0-9 | A-Z | a-z.

Identifier must start from a letter.

Identifiers:

Regular Expression:  $[a-zA-Z][a-zA-Z_0-9]^*$

(a) starting =  $[a-zA-Z]$   
(b) final =  $[a-zA-Z_0-9]$

NFA:

ε-closure:

$\epsilon\text{-closure}(1) = \{1\} \rightarrow A$   
 $(2) = \{2, 3, 5\}$   
 $(3) = \{3\}$   
 $(4) = \{3, 4, 5\}$   
 $(5) = \{5\}$

DFA

Move:

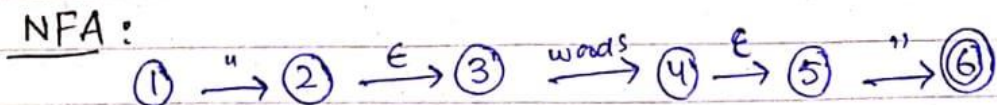
$\epsilon(\text{MOVE}(A, a)) = \{1\} \xrightarrow{2} \epsilon\text{-closure}(2) = \{2, 3, 5\} (B)$   
 $(A, b) = \{ \}$   
 $(B, a) = \{2, 3, 5\} = \emptyset$   
 $(B, b) = \{2, 3, 5\} = \epsilon(4) = \{3, 4, 5\} (C)$   
 $(C, a) = \{3, 4, 5\} = \emptyset$   
 $(C, b) = \{3, 4, 5\} = \epsilon(4) = (C)$

## Strings:

String constant is a series of characters, digits, spaces, or escape sequences between “.

Strings :-  
RE : “[\n]”

words = “[\n]”



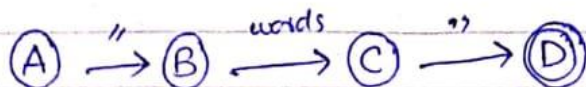
ε-closure :

$$\begin{aligned} \epsilon\text{-closure}(1) &= \{1\} \rightarrow (A) & \epsilon(4) &= \{4, 5\} \\ \epsilon(2) &= \{2, 3\} & \epsilon(5) &= \{5\} \\ \epsilon(3) &= \{3\} & \epsilon(6) &= \{6\} \end{aligned}$$

Move :

$$\begin{aligned} \epsilon(\text{move}(A, \text{"})) &= \epsilon(2) = \{2, 3\} = (B) \\ \epsilon(\text{move}(B, \text{words})) &= \epsilon(4) = \{4, 5\} = (C) \\ \epsilon(\text{move}(C, \text{"})) &= \epsilon(6) = \{6\} = (D) \\ \epsilon(\text{move}(D, \text{"})) &= \emptyset \end{aligned}$$

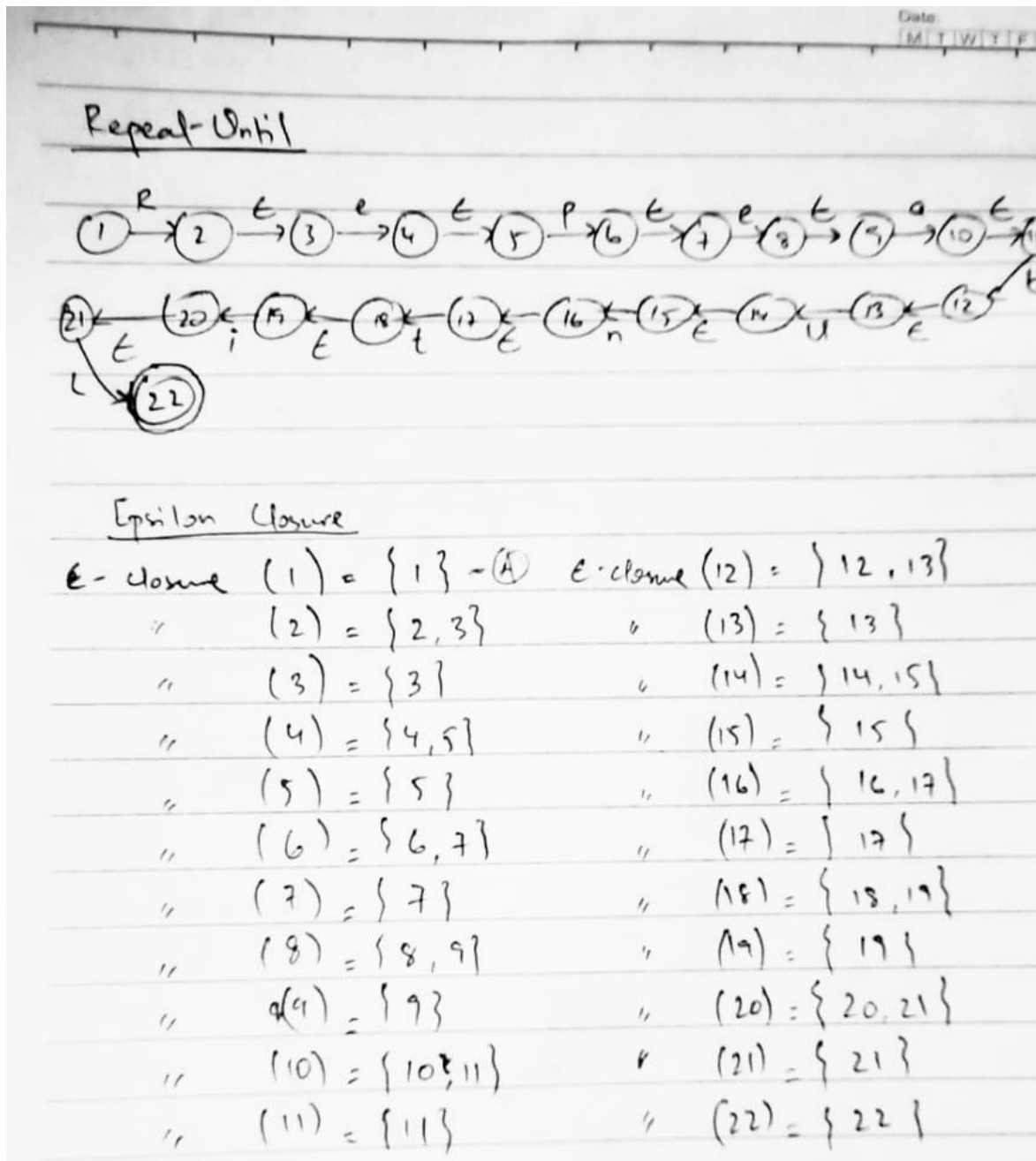
DFA :



**Keywords:**

Pedestal includes keywords that best defines the concepts of code control flow. Hence, they are described in natural language (English only.)

### *RepeatUntil (For):*





Move

$$\epsilon\text{-clone}(\text{move}(A, r)) = \epsilon\text{-clone}(2) = \{2, 3\} \rightarrow \textcircled{B}$$

$$" (\text{move}(B, c)) = " (4) = \{4, 5\} \rightarrow \textcircled{C}$$

$$" (\text{move}(C, p)) = " (6) = \{6, 7\} \rightarrow \textcircled{D}$$

$$" (\text{move}(D, e)) = " (8) = \{8, 9\} \rightarrow \textcircled{E}$$

$$" (\text{move}(E, a)) = " (10) = \{10, 11\} \rightarrow \textcircled{F}$$

$$" (\text{move}(F, t)) = " (12) = \{12, 13\} \rightarrow \textcircled{G}$$

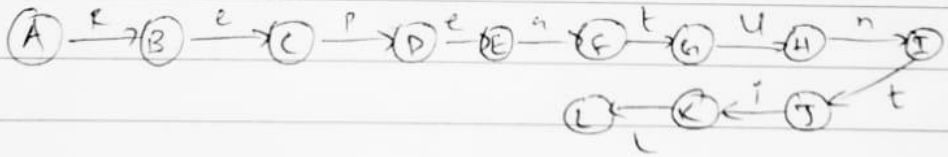
$$" (\text{move}(G, u)) = " (14) = \{14, 15\} \rightarrow \textcircled{H}$$

$$" (\text{move}(H, n)) = " (16) = \{16, 17\} \rightarrow \textcircled{I}$$

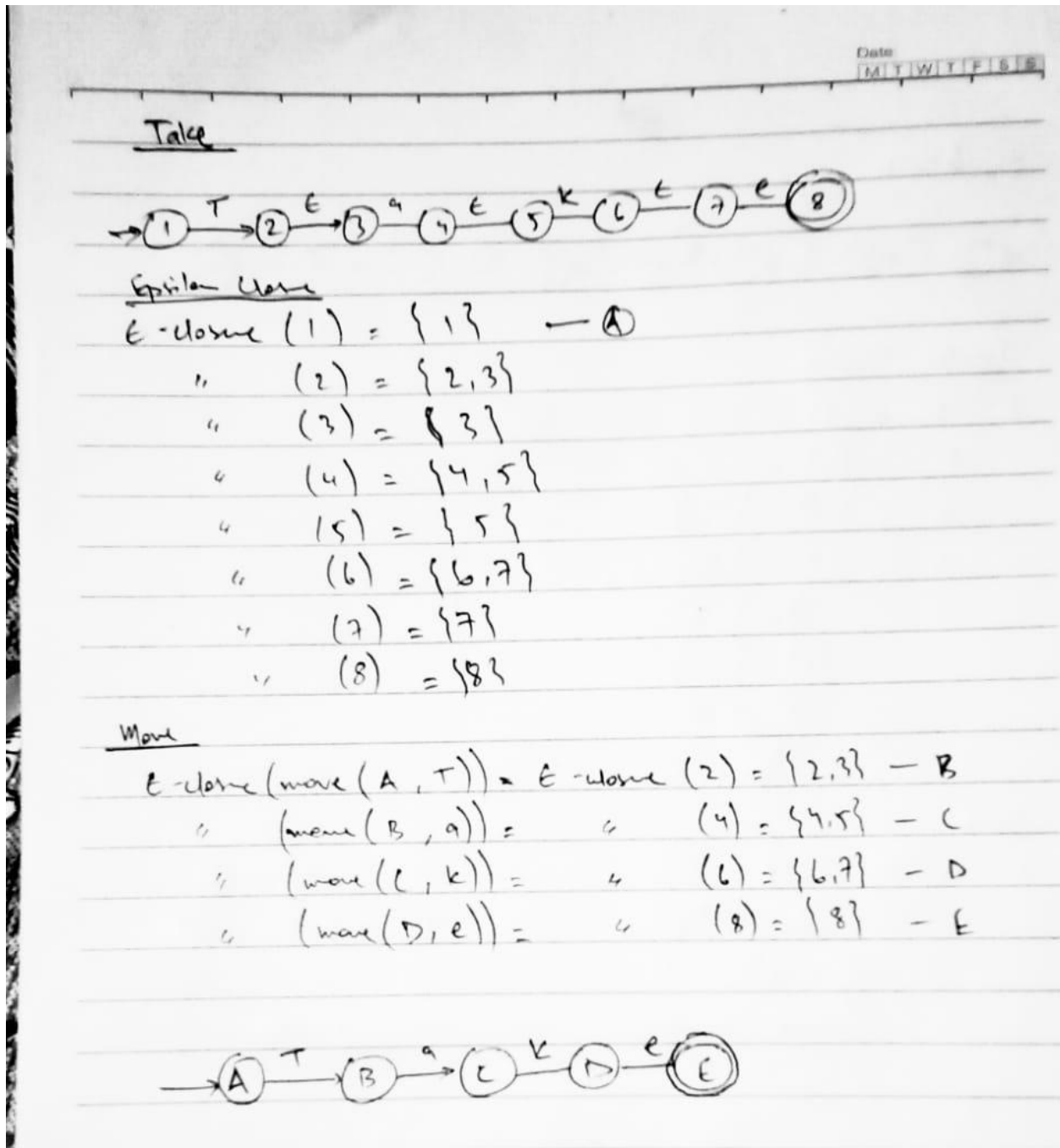
$$" (\text{move}(I, i)) = " (18) = \{18, 19\} \rightarrow \textcircled{J}$$

$$" (\text{move}(J, l)) = " (20) = \{20, 21\} \rightarrow \textcircled{K}$$

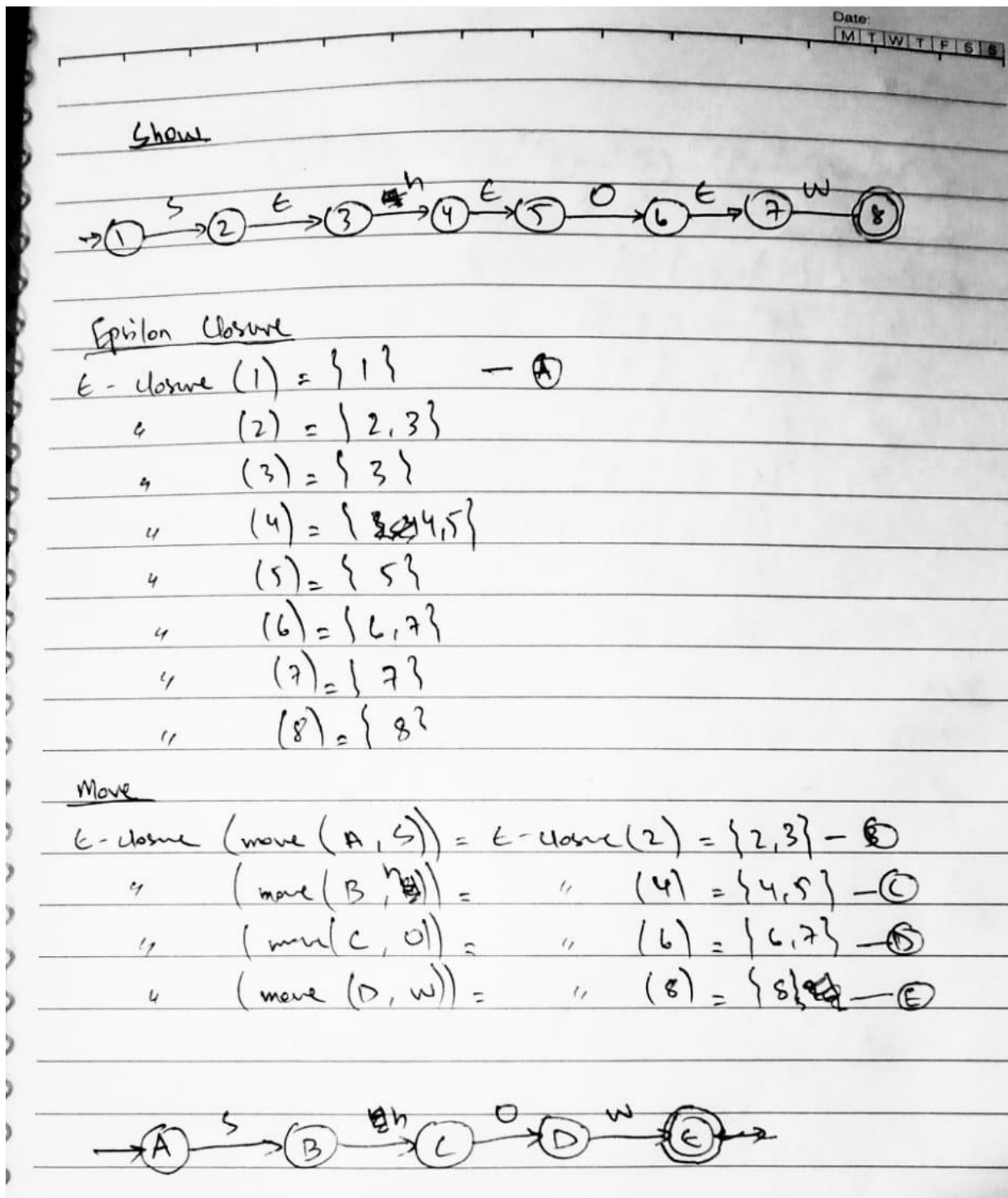
$$" (\text{move}(K, l)) = " (22) = \{22\} \rightarrow \textcircled{L}$$



### Take (Input):



Show (Print):





## Integer Container (int):

Date: M T W T F S S

### Integer Container

### Epsilon Closure

$\epsilon\text{-closure}(1) = \{1\} \rightarrow A$	$\epsilon\text{-closure}(17) = \{17, 18\}$
" $(2) = \{2, 3\}$	" $(18) = \{18, 19\}$
" $(3) = \{3\}$	" $(19) = \{19\}$
" $(4) = \{4, 5\}$	" $(20) = \{20, 21\}$
" $(5) = \{5\}$	" $(21) = \{21\}$
" $(6) = \{6, 7\}$	" $(22) = \{22, 23\}$
" $(7) = \{7\}$	" $(23) = \{23\}$
" $(8) = \{8, 9\}$	" $(24) = \{24, 25\}$
" $(9) = \{9\}$	" $(25) = \{25\}$
" $(10) = \{10, 11\}$	" $(26) = \{26, 27\}$
" $(11) = \{11\}$	" $(27) = \{27\}$
" $(12) = \{12, 13\}$	" $(28) = \{28, 29\}$
" $(13) = \{13\}$	" $(29) = \{29\}$
" $(14) = \{14, 15\}$	" $(30) = \{30, 31\}$
" $(15) = \{15\}$	" $(31) = \{31\}$
" $(16) = \{16, 17\}$	" $(32) = \{32\}$

More

$$E\text{-}clone(M(A, 1)) = E\text{-}clone(2) = \{2, 3\} - B$$

$$" (M(B, n)) = " (4) = \{4, 5\} - C$$

$$" (M(C, t)) = " (6) = \{6, 7\} - D$$

$$" (M(D, e)) = " (8) = \{8, 9\} - E$$

$$" (M(E, g)) = " (10) = \{10, 11\} - F$$

$$" (M(F, e)) = " (12) = \{12, 13\} - G$$

$$" (M(G, v)) = " (14) = \{14, 15\} - H$$

$$" (M(H, l)) = " (16) = \{16, 17\} - I$$

$$" (M(I, o)) = " (18) = \{18, 19\} - J$$

$$" (M(J, n)) = " (20) = \{20, 21\} - K$$

$$" (M(K, t)) = " (22) = \{22, 23\} - L$$

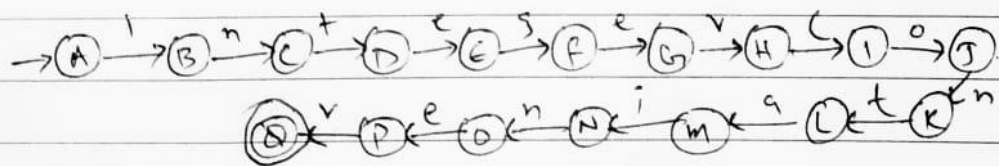
$$" (M(L, a)) = " (24) = \{24, 25\} - M$$

$$" (M(M, i)) = " (26) = \{26, 27\} - N$$

$$" (M(N, n)) = " (28) = \{28, 29\} - O$$

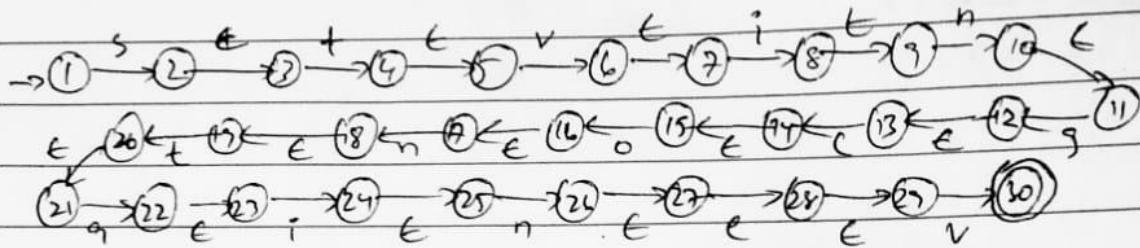
$$" (M(O, e)) = " (30) = \{30, 31\} - P$$

$$" (M(P, v)) = " (32) = \{32\} - Q$$



**stringContainer (string):**

### String Container



### Epsilon Closure

$\epsilon$ -closure (1) = {1} - A     $\epsilon$ -closure (16) = {16, 17}

$\epsilon$  (2) = {2, 3}

$\epsilon$  (17) = {17}

$\epsilon$  (3) = {3}

$\epsilon$  (18) = {18, 19}

$\epsilon$  (4) = {4, 5}

$\epsilon$  (19) = {19}

$\epsilon$  (5) = {5}

$\epsilon$  (20) = {20, 21}

$\epsilon$  (6) = {6, 7}

$\epsilon$  (21) = {22}

$\epsilon$  (7) = {7}

$\epsilon$  (22) = {22, 23}

$\epsilon$  (8) = {8, 9}

$\epsilon$  (23) = {23}

$\epsilon$  (9) = {9}

$\epsilon$  (24) = {24, 25}

$\epsilon$  (10) = {10, 11}

$\epsilon$  (25) = {25}

$\epsilon$  (11) = {11}

$\epsilon$  (26) = {26, 27}

$\epsilon$  (12) = {12, 13}

$\epsilon$  (27) = {27}

$\epsilon$  (13) = {13}

$\epsilon$  (28) = {28, 29}

$\epsilon$  (14) = {14, 15}

$\epsilon$  (29) = {29}

$\epsilon$  (15) = {15}

$\epsilon$  (30) = {30}

Move

1 closer (move (A, s)) = 1 closer (2) = {2, 3} - B

2 (m (B, t)) = " (4) = {4, 5} - C

3 (m (C, v)) = " (6) = {6, 7} - D

4 (m (D, i)) = " (8) = {8, 9} - E

5 (m (E, n)) = " (10) = {10, 11} - F

6 (m (F, g)) = " (12) = {12, 13} - G

7 (m (G, l)) = " (14) = {14, 15} - H

8 (m (H, o)) = " (16) = {16, 17} - I

9 (m (I, u)) = " (18) = {18, 19} - J

10 (m (J, t)) = " (20) = {20, 21} - K

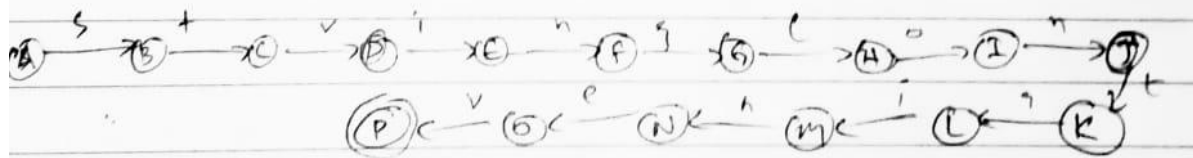
11 (m (K, q)) = " (22) = {22, 23} - L

12 (m (L, i)) = " (24) = {24, 25} - M

13 (m (M, n)) = " (26) = {26, 27} - N

14 (m (N, e)) = " (28) = {28, 29} - O

15 (m (O, v)) = " (30) = {30, 31} - P

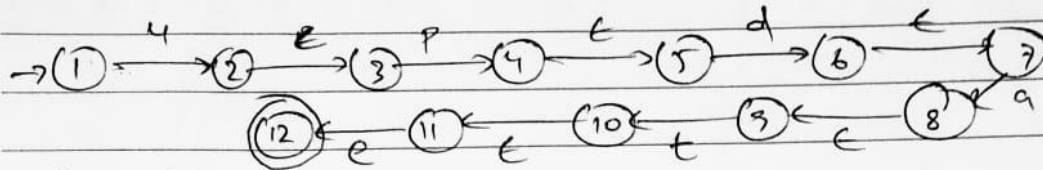


Update (i++):

Date: 

M	T	W	T	F	S	S
---	---	---	---	---	---	---

Update



Epsilon Closure

$\epsilon$ -closure (1) = {1} - A       $\epsilon$ -closure (7) = {7}

" (2) = {2, 3}

" (8) = {8, 9}

" (3) = {3}

" (9) = {9}

" (4) = {4, 5}

" (10) = {10, 11}

" (5) = {5}

" (11) = {11}

~~" (6) = {6, 7}~~

" (12) = {12}

" (6) = {6, 7}

Move

$\epsilon$ -closure (move (A, u)) =  $\epsilon$ -closure (2) = {2, 3} - B

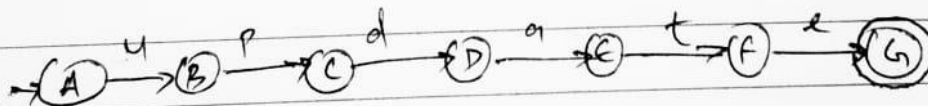
" (move (B, p)) = " (4) = {4, 5} - C

" (move (C, d)) = " (6) = {6, 7} - D

" (move (D, a)) = " (8) = {8, 9} - E

" (move (E, t)) = " (10) = {10, 11} - F

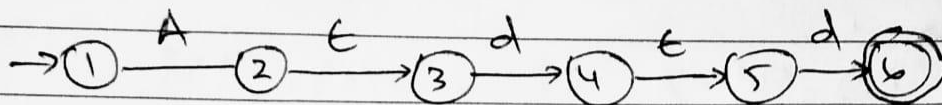
" (move (F, e)) = " (12) = {12} - G



## Keywords:

add (+):

Add



$$\epsilon\text{-close}(1) = \{1\} - A'$$

$$\hookrightarrow (2) = \{2, 3\}$$

$$\hookrightarrow (3) = \{3\}$$

$$\hookrightarrow (4) = \{4, 5\}$$

$$\hookrightarrow (5) = \{5\}$$

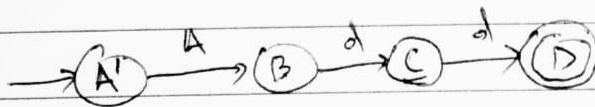
$$\hookrightarrow (6) = \{6\}$$

Move

$$\epsilon\text{-close}(\text{move}(A', A)) = \epsilon\text{-close}(2) = \{2, 3\} - B$$

$$\hookrightarrow (\text{move}(B, d)) = \hookrightarrow (4) = \{4, 5\} - C$$

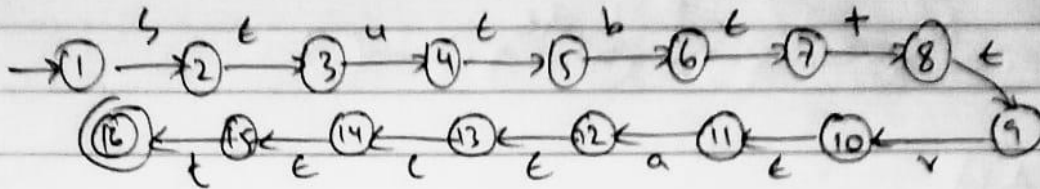
$$\hookrightarrow (\text{move}(C, d)) = \hookrightarrow (6) = \{6\} - D$$





subtract (-):

Subtract



Epsilon Closure

$$\epsilon\text{-closure}(1) = \{1\} - A \quad \epsilon\text{-closure}(9) = \{9\}$$

$$\epsilon\text{-closure}(2) = \{2, 3\}$$

$$\epsilon\text{-closure}(10) = \{10, 11\}$$

$$\epsilon\text{-closure}(3) = \{3\}$$

$$\epsilon\text{-closure}(11) = \{11, 12\}$$

$$\epsilon\text{-closure}(4) = \{4, 5\}$$

$$\epsilon\text{-closure}(12) = \{12, 13\}$$

$$\epsilon\text{-closure}(5) = \{5\}$$

$$\epsilon\text{-closure}(13) = \{13\}$$

$$\epsilon\text{-closure}(6) = \{6, 7\}$$

$$\epsilon\text{-closure}(14) = \{14, 15\}$$

$$\epsilon\text{-closure}(7) = \{7\}$$

$$\epsilon\text{-closure}(15) = \{15\}$$

$$\epsilon\text{-closure}(8) = \{8, 9\}$$

$$\epsilon\text{-closure}(16) = \{16\}$$

Move

$$\epsilon\text{-closure}(\text{move}(A, s)) = \epsilon\text{-closure}(2) = \{2, 3\} - B$$

$$\epsilon\text{-closure}(\text{move}(B, u)) = \epsilon\text{-closure}(4) = \{4, 5\} - C$$

$$\epsilon\text{-closure}(\text{move}(C, b)) = \epsilon\text{-closure}(6) = \{6, 7\} - D$$

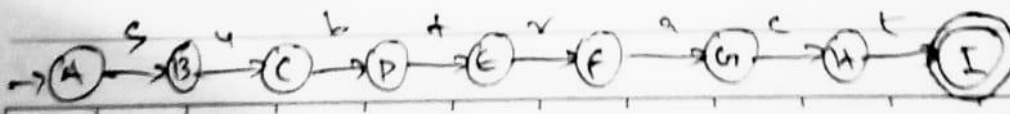
$$\epsilon\text{-closure}(\text{move}(D, +)) = \epsilon\text{-closure}(8) = \{8, 9\} - E$$

$$\epsilon\text{-closure}(\text{move}(E, v)) = \epsilon\text{-closure}(10) = \{10, 11\} - F$$

$$\epsilon\text{-closure}(\text{move}(F, a)) = \epsilon\text{-closure}(12) = \{12, 13\} - G$$

$$\epsilon\text{-closure}(\text{move}(G, c)) = \epsilon\text{-closure}(14) = \{14, 15\} - H$$

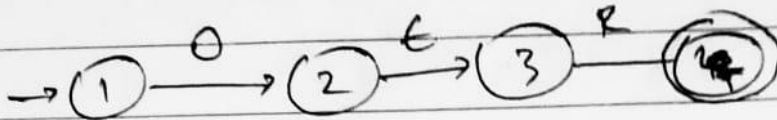
$$\epsilon\text{-closure}(\text{move}(H, e)) = \epsilon\text{-closure}(16) = \{16\} - I$$



## Operators:

Or (/):

OR



Epsilon Closure

$$\epsilon\text{-closure}(1) = \{1\} - A$$

$$\hookrightarrow (2) = \{2, 3\}$$

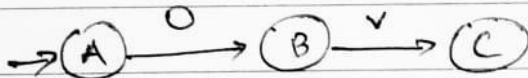
$$\hookrightarrow (3) = \{3\}$$

$$\hookrightarrow (4) = \{4\}$$

Move

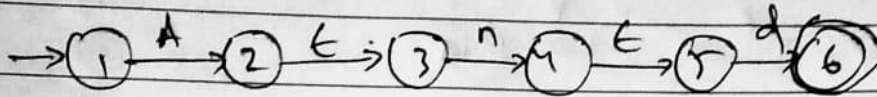
$$\epsilon\text{-closure}(\text{move}(A, 0)) = \epsilon\text{-closure}(2) = \{2, 3\} - B$$

$$\hookrightarrow (4) (\text{move}(B, v)) = \{4\} - C$$



and (&):

Answer



Epsilon Closure

$$\epsilon\text{-closure}(1) = \{1\} - A'$$

$$\hookrightarrow (2) = \{2, 3\}$$

$$\hookrightarrow (3) = \{3\}$$

$$\hookrightarrow (4) = \{4, 5\}$$

$$\hookrightarrow (5) = \{5\}$$

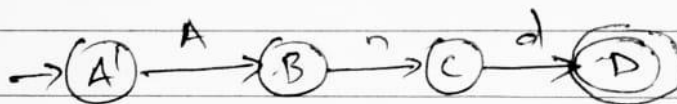
$$\hookrightarrow (6) = \{6\}$$

Move

$$\epsilon\text{-closure}(\text{move}(A', A)) = \epsilon\text{-closure}(2) = \{2, 3\} - B$$

$$\hookrightarrow (1, B, n) = \hookrightarrow (4) = \{4, 5\} - C$$

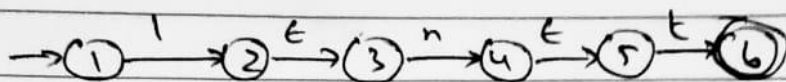
$$\hookrightarrow (C, d) = \hookrightarrow (6) = \{6\} - D$$



## Data types:

*int:*

Int



Epsilon Closure

$$\epsilon\text{-closure}(1) = \{1\} - A$$

$$\hookrightarrow (2) = \{2, 3\}$$

$$\hookrightarrow (3) = \{3\}$$

$$\hookrightarrow (4) = \{4, 5\}$$

$$\hookrightarrow (5) = \{5\}$$

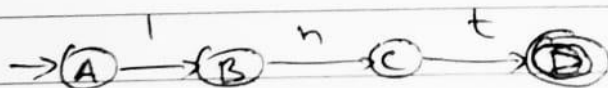
$$\hookrightarrow (6) = \{6\}$$

Move

$$\epsilon\text{-closure}(\text{move}(A, 1)) = \epsilon\text{-closure}(2) = \{2, 3\} - B$$

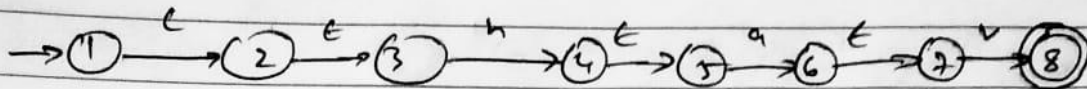
$$\hookrightarrow (B, n) = \hookrightarrow (4) = \{4, 5\} - C$$

$$\hookrightarrow (C, t) = \hookrightarrow (6) = \{6, 7\} - D$$



char:

Char



Epsilon Closure

$$\epsilon\text{-closure}(1) = \{1\} \text{ --- A}$$

$$\text{"/ } (2) = \{2, 3\}$$

$$\text{"/ } (3) = \{3\}$$

$$\text{"/ } (4) = \{4, 5\}$$

$$\text{"/ } (5) = \{5\}$$

$$\text{"/ } (6) = \{6, 7\}$$

$$\text{"/ } (7) = \{7\}$$

$$\text{"/ } (8) = \{8\}$$

Move

$$\epsilon\text{-closure}(\text{move}(A, c)) = \epsilon\text{-closure}(2) = \{2, 3\} \text{ --- B}$$

$$\text{"/ } (B, h) = \text{"/ } (4) = \{4, 5\} \text{ --- C}$$

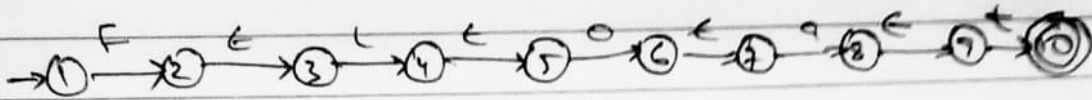
$$\text{"/ } (C, a) = \text{"/ } (5) = \{5, 6\} \text{ --- D}$$

$$\text{"/ } (D, v) = \text{"/ } (6) = \{6, 7\} \text{ --- E}$$



float:

float



Epsilon Closure

$$\epsilon\text{-closure}(1) = \{1\} - A \quad \epsilon\text{-closure}(6) = \{6, 7\}$$

$$, \quad (2) = \{2, 3\} \quad , \quad (7) = \{7\}$$

$$, \quad (3) = \{3\} \quad , \quad (8) = \{8, 9\}$$

$$, \quad (4) = \{4, 5\} \quad , \quad (9) = \{9\}$$

$$, \quad (5) = \{5\} \quad , \quad (10) = \{10\}$$

Move

$$\epsilon\text{-closure}(\text{move}(A, F)) = \epsilon\text{-closure}(2) = \{2, 3\} - B$$

$$, \quad (\text{move}(B, L)) = , \quad (4) = \{4, 5\} - C$$

$$, \quad (\text{move}(C, O)) = , \quad (6) = \{6, 7\} - D$$

$$, \quad (\text{move}(D, 9)) = , \quad (8) = \{8, 9\} - E$$

$$, \quad (\text{move}(E, t)) = , \quad (10) = \{10\} - F$$

