

(1)

(1-a)

Letter  $\rightarrow$  [b-d f-h j-n p-t v-z]

String  $\rightarrow$  (Letter|a)\* (Letter|e)\* (Letter|i)\* (Letter|o)\* (Letter|u)\*

String  $\rightarrow$

Letter\*a+(Letter|a)\*Letter\*e+(Letter|e)\*Letter\*i+(Letter|i)\*Letter\*o+(Letter|o)\*Letter\*u+(Letter|u)\*

(1-b)

String  $\rightarrow$  a\*b\*c\*d\*.....z\*

(1-c)

Character  $\rightarrow$  [a-zA-Z0-9]

Comment  $\rightarrow$  /\* (Character|"/" |(\*|/) Character)\* \*/

(1-d)

b\* (a (∈ | b))\*

(1-e)

Let DNOTZ be the set of digits from 1 to 9.

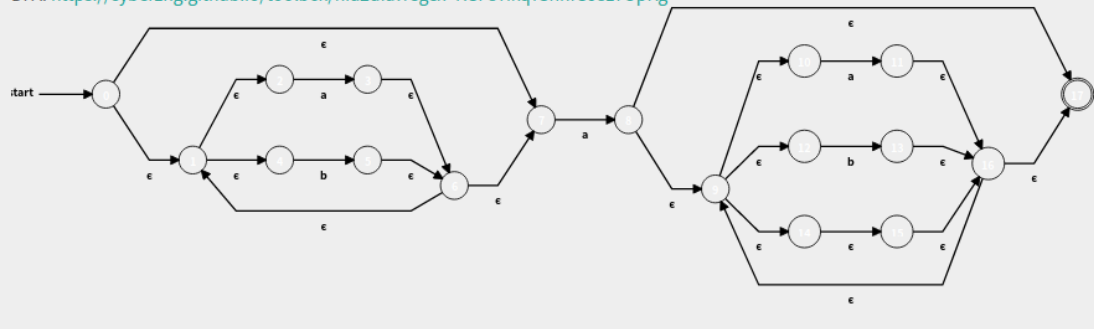
Let D be the set of digits from 0 to 9.

Define  $(0 \mid (\text{DNOTZ } D^*)) \cdot (0 \mid (D^* \text{ DNOTZ}))$

(2)

(2-a)

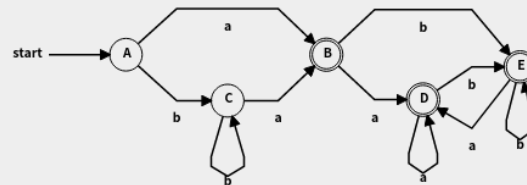
DFA: <https://cyberzhg.github.io/toolbox/nfa2dfa?regex=KGF8YikqYShhfGJ8z7UpKg==>



(2-b)

NFA: <https://cyberzhg.github.io/toolbox/regex2nfa?regex=KGF8YikqYShhfGJ8z7UpKg==>  
 Min-DFA: [https://cyberzhg.github.io/toolbox/min\\_dfa?regex=KGF8YikqYShhfGJ8z7UpKg==](https://cyberzhg.github.io/toolbox/min_dfa?regex=KGF8YikqYShhfGJ8z7UpKg==)

NFA STATE	DFA STATE	TYPE	a	b
{0,1,2,4,7}	A		B	C
{1,2,3,4,6,7,8,9,10,12,14,15,16,17}	B	accept	D	E
{1,2,4,5,6,7}	C		B	C
{1,2,3,4,6,7,8,9,10,11,12,14,15,16,17}	D	accept	D	E
{1,2,4,5,6,7,9,10,12,13,14,15,16,17}	E	accept	D	E



(3)

(3-a)

$\text{exp} \rightarrow \text{exp addOp term}$   
 $\rightarrow \text{exp addOp term addOp term}$   
 $\rightarrow \text{term addOp term addOp term}$   
 $\rightarrow \text{factor addOp term addOp term}$   
 $\rightarrow \text{number addOp term addOp term}$   
 $\rightarrow \text{number} + \text{term addOp term}$   
 $\rightarrow \text{number} + \text{term multOp factor addOp term}$   
 $\rightarrow \text{number} + \text{factor multOp factor addOp term}$   
 $\rightarrow \text{number} + \text{number multOp factor addOp term}$   
 $\rightarrow \text{number} + \text{number} * \text{factor addOp term}$   
 $\rightarrow \text{number} + \text{number} * \text{number addOp term}$   
 $\rightarrow \text{number} + \text{number} * \text{number} - \text{term}$   
 $\rightarrow \text{number} + \text{number} * \text{number} - \text{factor}$   
 $\rightarrow \text{number} + \text{number} * \text{number} - \text{number}$

(3-b)

exp  $\rightarrow$  term

- $\rightarrow$  term multop factor
- $\rightarrow$  factor multop factor
- $\rightarrow$  number multop factor
- $\rightarrow$  number multop ( exp )
- $\rightarrow$  number \* ( exp )
- $\rightarrow$  number \* ( exp addop term )
- $\rightarrow$  number \* ( exp addop term addop term )
- $\rightarrow$  number \* ( term addop term addop term )
- $\rightarrow$  number \* ( factor addop term addop term )
- $\rightarrow$  number \* ( number addop term addop term )
- $\rightarrow$  number \* ( number – term addop term )
- $\rightarrow$  number \* ( number – factor addop term )
- $\rightarrow$  number \* ( number – number addop term )
- $\rightarrow$  number \* ( number – number + term )
- $\rightarrow$  number \* ( number – number + factor )
- $\rightarrow$  number \* ( number – number + number )

(3-c)

exp  $\rightarrow$  exp addop term

- $\rightarrow$  term addop term
- $\rightarrow$  factor addop term
- $\rightarrow$  number addop term
- $\rightarrow$  number – term
- $\rightarrow$  number – factor
- $\rightarrow$  number – ( exp )
- $\rightarrow$  number – ( exp addop term )
- $\rightarrow$  number – ( term addop term )
- $\rightarrow$  number – ( factor addop term )
- $\rightarrow$  number – ( number addop term )
- $\rightarrow$  number – ( number + term )
- $\rightarrow$  number – ( number + term multop factor )
- $\rightarrow$  number – ( number + factor multop factor )
- $\rightarrow$  number – ( number + number multop factor )
- $\rightarrow$  number – ( number + number \* factor )
- $\rightarrow$  number – ( number + number \* number )

(4)

$$\begin{aligned}
 E &\rightarrow E \text{ or } T \mid T \\
 T &\rightarrow T \text{ and } F \mid F \\
 F &\rightarrow \text{not } F \mid B \\
 B &\rightarrow \text{true} \mid \text{false} \mid ( E )
 \end{aligned}$$

5.

<https://ideone.com/bAPCYW>

6.

(6-a)

FIRST	FOLLOW	Nonterminal
{num, lparen}	{ \$ }	Start
{num, lparen}	{ \$, num, lparen, rparen }	Value
{plus, prod}	{ rparen }	Expr
{num, lparen, ' '}	{ rparen }	Values

(6-b)

Predict(Start->Value)={num, lparen}

Predict(Value->num)={num}

Predict(Value->lparen Expr rparen)={lparen}

Predict(Expr->plus Value Value)={plus}

Predict(Expr->prod Values)={prod}

Predict(Values->Value Values)={num, lparen}

Predict(Values->λ)={rparen}

(6-c)

Nonterminal	num	lparen	rparen	plus	prod	\$
Start	Start->Value	Start->Value				
Value	Value->num	Value->lparen Expr rparen				
Expr				Expr->plus Value Value	Expr->prod Values	
Values	Values->Value Values	Values->Value Values	Values-> ' '			

(6-d)

Trace		
Stack	Input	Rule
\$ Start	lparen plus num lparen prod num num num rparen rparen \$	
\$ Value	lparen plus num lparen prod num num num rparen rparen \$	Start->Value
\$ rparen Expr lparen	lparen plus num lparen prod num num num rparen rparen \$	Value->lparen Expr rparen
\$ rparen Expr	plus num lparen prod num num num rparen rparen \$	
\$ rparen Value Value plus	plus num lparen prod num num num rparen rparen \$	Expr->plus Value Value
\$ rparen Value Value	num lparen prod num num num rparen rparen \$	
\$ rparen Value num	num lparen prod num num num rparen rparen \$	Value->num
\$ rparen Value	lparen prod num num num rparen rparen \$	
\$ rparen rparen Expr lparen	lparen prod num num num rparen rparen \$	Value->lparen Expr rparen
\$ rparen rparen Expr	prod num num num rparen rparen \$	
\$ rparen rparen Values prod	prod num num num rparen rparen \$	Expr->prod Values
\$ rparen rparen Values	num num num rparen rparen \$	
\$ rparen rparen Values Value	num num num rparen rparen \$	Values->Value Values
\$ rparen rparen Values num	num num num rparen rparen \$	Value->num
\$ rparen rparen Values	num num rparen rparen \$	
\$ rparen rparen Values Value	num num rparen rparen \$	Values->Value Values
\$ rparen rparen Values num	num num rparen rparen \$	Value->num
\$ rparen rparen Values	num rparen rparen \$	
\$ rparen rparen Values Value	num rparen rparen \$	Values->Value Values
\$ rparen rparen Values num	num rparen rparen \$	Value->num
\$ rparen rparen Values	rparen rparen \$	
\$ rparen rparen	rparen rparen \$	Values->' '
\$ rparen	rparen \$	
\$	\$	

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$A1 \rightarrow A2 \beta_1 A1'$   
 $\quad | A3 \beta_2 A1'$   
 $A2 \rightarrow A3 \beta_2 A1' \beta_3 A2'$   
 $\quad | A3 \beta_4 A2'$   
 $A1' \rightarrow \alpha_1 A1'$   
 $\quad | \alpha_2 A1'$   
 $\quad | \alpha_3 A1'$   
 $\quad | \epsilon$   
 $A2' \rightarrow \alpha_4 A2'$   
 $\quad | \beta_1 A1' \beta_3 A2'$   
 $\quad | \epsilon$   
 $A3' \rightarrow \alpha_5 A3'$   
 $\quad | \beta_2 A1' \beta_3 A2' \beta_1 A1' \beta_5 A3'$   
 $\quad | \beta_4 A2' \beta_1 A1' \beta_5 A3'$   
 $\quad | \beta_2 A1' \beta_5 A3'$   
 $\quad | \beta_2 A1' \beta_3 A2' \beta_6 A3'$   
 $\quad | \beta_4 A2' \beta_6 A3'$   
 $\quad | \epsilon$