***Context Free Grammar***

|  |  |  |  |
| --- | --- | --- | --- |
| # | Non-terminal Symbol |  | Expression |
|  | <program> | → | <global> Lead : Start <statements> End . <taskdef> |
|  | <global> | → | <global\_choice> . <global> |
|  | <global> | → | λ |
|  | <global\_choice> | → | <let\_global> |
|  | <global\_choice> | → | <vardec> |
|  | <global\_choice> | → | <array> |
|  | <global\_choice> | → | <task> |
|  | <global\_choice> | → | <object> |
|  | <datatype> | → | Int id |
|  | <datatype> | → | Double id |
|  | <datatype> | → | Char id |
|  | <datatype> | → | String id |
|  | <datatype> | → | Boolean id |
|  | <let\_global> | → | Let id is <values> |
|  | <values> | → | intlit |
|  | <values> | → | doublelit |
|  | <values> | → | stringlit |
|  | <values> | → | charlit |
|  | <values> | → | boollit |
|  | <vardec> | → | Var <vardtype> |
|  | <vardtype> | → | Int id <varinitINT><vartailINT> |
|  | <vardtype> | → | Double id <varinitDOUBLE><vartailDOUBLE> |
|  | <vardtype> | → | Char id <varinitCHAR><vartailCHAR> |
|  | <vardtype> | → | String id <varinitSTRING><vartailSTRING> |
|  | <vardtype> | → | Boolean id <varinitBOOLEAN><vartailBOOLEAN> |
|  | <varinitINT> | → | is <mathopINT> |
|  | <varinitINT> | → | Λ |
|  | <varinitDOUBLE> | → | is <mathopDOUBLE> |
|  | <varinitDOUBLE> | → | Λ |
|  | <varinitCHAR> | → | is <valueCHAR> |
|  | <varinitCHAR> | → | Λ |
|  | <varinitSTRING> | → | is <valueSTRING> |
|  | <varinitSTRING> | → | Λ |
|  | <varinitBOOLEAN> | → | is <valueBOOLEAN> |
|  | <varinitBOOLEAN> | → | Λ |
|  | <vartailINT> | → | ; id <varinitINT><vartailINT> |
|  | <vartailINT> | → | Λ |
|  | <vartailDOUBLE> | → | ; id <varinitDOUBLE><vartailDOUBLE> |
|  | <vartailDOUBLE> | → | Λ |
|  | <vartailCHAR> | → | ; id <varinitCHAR><vartailCHAR> |
|  | <vartailCHAR> | → | Λ |
|  | <vartailSTRING> | → | ; id <varinitSTRING><vartailSTRING> |
|  | <vartailSTRING> | → | Λ |
|  | <vartailBOOLEAN> | → | ; id <varinitBOOLEAN><vartailBOOLEAN> |
|  | <vartailBOOLEAN> | → | Λ |
|  | <valueCHAR> | → | Charlit |
|  | <valueCHAR> | → | id <id\_tail> |
|  | <valueSTRING> | → | Stringlit |
|  | <valueSTRING> | → | id <id\_tail> |
|  | <valueBOOLEAN> | → | Boollit |
|  | <valueBOOLEAN> | → | id <id\_tail> |
|  | <id\_tail> | → | <ids\_tail> |
|  | <id\_tail> | → | ( <task\_param> ) |
|  | <ids\_tail> | → | <id\_choices> |
|  | <ids\_tail> | → | Λ |
|  | <id\_choices> | → | @ <elements> |
|  | <id\_choices> | → | [ <index> ] <index\_tail> |
|  | <task\_param> | → | <value><task\_param\_tail> |
|  | <task\_param> | → | Λ |
|  | <task\_param\_tail> | → | ; <task\_param> |
|  | <task\_param\_tail> | → | Λ |
|  | <value> | → | <values> |
|  | <value> | → | <elements> |
|  | <index> | → | <index\_value><indexop> |
|  | <indexop> | → | <add\_min><index\_value> |
|  | <add\_min> | → | + |
|  | <add\_min> | → | - |
|  | <index\_value> | → | Id |
|  | <index\_value> | → | Intlit |
|  | <index\_tail> | → | [ <index> ] |
|  | <elements> | → | id <elements\_tail> |
|  | <elements\_tail> | → | @ <elements> |
|  | <elements\_tail> | → | Λ |
|  | <array> | → | Array <datatype> of intlit <size\_tail> |
|  | <size\_tail> | → | by intlit |
|  | <size\_tail> | → | Λ |
|  | <task> | → | Task <return\_type><parameters> |
|  | <return\_type> | → | <datatype> |
|  | <return\_type> | → | Null id |
|  | <parameters> | → | ( <datatype><param\_tail> ) |
|  | <parameters> | → | Λ |
|  | <param\_tail> | → | ; <datatype><param\_tail> |
|  | <param\_tail> | → | Λ |
|  | <object> | → | Object id Start <object\_elem> End <object\_var> |
|  | <object\_elem> | → | Var <datatype> . <object\_elem\_tail> |
|  | <object\_elem> | → | Object id id . <object\_elem\_tail> |
|  | <object\_elem\_tail> | → | <object\_elem> |
|  | <object\_elem\_tail> | → | Λ |
|  | <object\_var> | → | id <object\_var\_tail> |
|  | <object\_var> | → | Λ |
|  | <object\_var\_tail> | → | ; <object\_var> |
|  | <object\_var\_tail> | → | Λ |
|  | <statements> | → | <functions> . <statements> |
|  | <statements> | → | Λ |
|  | <functions> | → | <vardec> |
|  | <functions> | → | <array> |
|  | <functions> | → | Object id id |
|  | <functions> | → | <io\_statement> |
|  | <functions> | → | <pre\_incdec> |
|  | <functions> | → | Clear |
|  | <functions> | → | <option> |
|  | <functions> | → | <IfOtherwise> |
|  | <functions> | → | <loopstate> |
|  | <functions> | → | <id\_stmt> |
|  | <io\_statement> | → | Read id <ids\_tail> |
|  | <io\_statement> | → | Say <output\_statement> |
|  | <output\_statement> | → | stringlit <concat> |
|  | <output\_statement> | → | <id\_choices><concat> |
|  | <concat> | → | , <output\_statement> |
|  | <concat> | → | Λ |
|  | <pre\_incdec> | → | ++ id |
|  | <pre\_incdec> | → | -- id |
|  | <option> | → | Option <elements> Start State <option\_choices> |
|  | <option\_choices> | → | <optionINT> |
|  | <option\_choices> | → | <optionCHAR> |
|  | <option\_choices> | → | <optionSTRING> |
|  | <optionINT> | → | intlit : <statements> Stop . <stateINT><default> End |
|  | <optionCHAR> | → | charlit : <statements> Stop . <stateCHAR><default> End |
|  | <optionSTRING> | → | stringlit : <statements> Stop . <stateSTRING><default> End |
|  | <stateINT> | → | State intlit : <statements> Stop . <stateINT> |
|  | <stateINT> | → | Λ |
|  | <stateCHAR> | → | State charlit : <statements> Stop . <stateCHAR> |
|  | <stateCHAR> | → | Λ |
|  | <stateSTRING> | → | State stringlit : <statements> Stop . <stateSTRING> |
|  | <stateSTRING> | → | Λ |
|  | <default> | → | Default : <statements> |
|  | <default> | → | Λ |
|  | <conditions> | → | <condition\_choices> |
|  | <conditions> | → | <negate> ( <condition\_choices> ) <logOp\_tail> |
|  | <condition\_choices> | → | id <condition\_ids><relOp><condition\_choices> |
|  | <condition\_choices> | → | <values><relOp><condition\_choices> |
|  | <condition\_ids> | → | <id\_choices> |
|  | <condition\_ids> | → | ( <task\_param> ) |
|  | <logOp\_tail> | → | <logOp><logOp\_choices><logOp\_tail> |
|  | <logOp\_tail> | → | Λ |
|  | <logOp\_choices> | → | <negate> ( <condition\_choices> ) |
|  | <logOp\_choices> | → | boollit <logOp\_tail> |
|  | <relOp> | → | == |
|  | <relOp> | → | != |
|  | <relOp> | → | > |
|  | <relOp> | → | >= |
|  | <relOp> | → | < |
|  | <relOp> | → | <= |
|  | <logOp> | → | && |
|  | <logOp> | → | || |
|  | <negate> | → | ! |
|  | <negate> | → | Λ |
|  | <IfOtherwise> | → | If ( <conditions> ) <cond\_loop><or><otherwise> EndIf |
|  | <or> | → | Or ( <conditions> ) <cond\_loop><or> |
|  | <or> | → | Λ |
|  | <otherwise> | → | Otherwise <cond\_loop><control> |
|  | <otherwise> | → | Λ |
|  | <cond\_loop> | → | <functions> . <control><cond\_loop> |
|  | <cond\_loop> | → | Λ |
|  | <control> | → | Skip . |
|  | <control> | → | Stop . |
|  | <control> | → | Λ |
|  | <loopstate> | → | Until ( <conditions> ) <cond\_loop> Loop |
|  | <loopstate> | → | Do <cond\_loop> LoopIf ( <conditions> ) |
|  | <loopstate> | → | For ( <initialize> ; <cond> ; <incdecvar> ) <cond\_loop> Loop |
|  | <initialize> | → | id = <init\_choices> |
|  | <initialize> | → | Λ |
|  | <init\_choices> | → | Intlit |
|  | <init\_choices> | → | Id |
|  | <cond> | → | <init\_choices><relOp><init\_choices> |
|  | <cond> | → | Λ |
|  | <incdecvar> | → | <incdec> id |
|  | <incdecvar> | → | id <incdec> |
|  | <id\_stmt> | → | id <id\_stmt\_tail> |
|  | <id\_stmt\_tail> | → | <ids\_tail> = <initvalues> |
|  | <id\_stmt\_tail> | → | ( <task\_param> ) |
|  | <initvalues> | → | <mathopNUM> |
|  | <initvalues> | → | Charlit |
|  | <initvalues> | → | Stringlit |
|  | <initvalues> | → | boollit |
|  | <mathopINT> | → | <intvalue><mathopINT\_tail> |
|  | <mathopINT> | → | ( <mathopINT> ) <mathopINT\_tail> |
|  | <mathopDOUBLE> | → | <doublevalue><mathopDOUBLE\_tail> |
|  | <mathopDOUBLE> | → | ( <mathopDOUBLE> ) <mathopDOUBLE\_tail> |
|  | <mathopNUM> | → | <numvalue><mathopNUM\_tail> |
|  | <mathopNUM> | → | ( <mathopNUM> ) <mathopNUM\_tail> |
|  | <intvalue> | → | Intlit |
|  | <intvalue> | → | <exprID> |
|  | <doublevalue> | → | Doublelit |
|  | <doublevalue> | → | <exprID> |
|  | <numvalue> | → | Intlit |
|  | <numvalue> | → | Doublelit |
|  | <numvalue> | → | <exprID> |
|  | <exprID> | → | id <id\_tail><incdec\_null> |
|  | <exprID> | → | <pre\_incdec><id\_tail> |
|  | <mathopINT\_tail> | → | <operators><mathopINT> |
|  | <mathopINT\_tail> | → | Λ |
|  | <mathopDOUBLE\_tail> | → | <operators><mathopDOUBLE> |
|  | <mathopDOUBLE\_tail> | → | Λ |
|  | <mathopNUM\_tail> | → | <operators><mathopNUM> |
|  | <mathopNUM\_tail> | → | Λ |
|  | <operators> | → | + |
|  | <operators> | → | - |
|  | <operators> | → | \* |
|  | <operators> | → | / |
|  | <operators> | → | % |
|  | <incdec> | → | ++ |
|  | <incdec> | → | -- |
|  | <incdec\_null> | → | <incdec> |
|  | <incdec\_null> | → | Λ |
|  | <taskdef> | → | Task <return\_id> End . <taskdef> |
|  | <taskdef> | → | Λ |
|  | <return\_id> | → | Int id : <taskbody> Response <returnINT> . |
|  | <return\_id> | → | Double id : <taskbody> Response <returnDOUBLE> . |
|  | <return\_id> | → | Char id : <taskbody> Response <returnCHAR> . |
|  | <return\_id> | → | String id : <taskbody> Response <returnSTRING> . |
|  | <return\_id> | → | Boolean id : <taskbody> Response <returnBOOLEAN> . |
|  | <return\_id> | → | Null id : <taskbody> |
|  | <taskbody> | → | Start <taskbodytail> |
|  | <taskbodytail> | → | <statements> |
|  | <returnINT> | → | Intlit |
|  | <returnINT> | → | id <returntail> |
|  | <returnDOUBLE> | → | Doublelit |
|  | <returnDOUBLE> | → | id <returntail> |
|  | <returnCHAR> | → | Charlit |
|  | <returnCHAR> | → | id <returntail> |
|  | <returnSTRING> | → | Stringlit |
|  | <returnSTRING> | → | id <returntail> |
|  | <returnBOOLEAN> | → | Boollit |
|  | <returnBOOLEAN> | → | id <returntail> |
|  | <returntail> | → | ( <task\_param> ) |
|  | <returntail> | → | <elements> |
|  | <returntail> | → | Λ |
|  | <StartProgram> | → | <program> # |