

GROUP-20  
DATE - 19/2/28

## GRAMMAR

$\langle \text{start} \rangle \rightarrow \langle \text{program} \rangle \$$

1.  $\langle \text{program} \rangle \rightarrow \langle \text{module Declarations} \rangle \langle \text{other Modules} \rangle \langle \text{driver Module} \rangle \langle \text{other Modules} \rangle$
2.  $\langle \text{module Declarations} \rangle \rightarrow \langle \text{module Declaration} \rangle \langle \text{module Declarations} \rangle \mid \epsilon$
3.  $\langle \text{module Declaration} \rangle \rightarrow \text{DECLARE MODULE ID SEMICOL}$
4.  $\langle \text{other Modules} \rangle \rightarrow \langle \text{module} \rangle \langle \text{other Modules} \rangle \mid \epsilon$
5.  $\langle \text{driver Module} \rangle \rightarrow \text{DRIVERDEF DRIVER PROGRAM DRIVERENDEF} \langle \text{module Def} \rangle$
6.  $\langle \text{module} \rangle \rightarrow \text{DEF MODULE ID ENDEF TAKES INPUT S\&B\&O} \langle \text{input-plist} \rangle \text{S\&B\&C SEMICOL} \langle \text{ret} \rangle \langle \text{module Def} \rangle$
7.  $\langle \text{ret} \rangle \rightarrow \text{RETURNS S\&B\&O} \langle \text{output-plist} \rangle \text{S\&B\&C SEMICOL} \mid \epsilon$
8.  $\langle \text{input-plist} \rangle \rightarrow \text{ID COLON} \langle \text{dataType} \rangle \langle \text{ip} \rangle$
9.  $\langle \text{ip} \rangle \rightarrow \text{COMMA ID COLON} \langle \text{dataType} \rangle \langle \text{ip} \rangle \mid \epsilon$
10.  $\langle \text{output-plist} \rangle \rightarrow \text{ID COLON} \langle \text{type} \rangle \langle \text{op} \rangle$
11.  $\langle \text{op} \rangle \rightarrow \text{COMMA ID COLON} \langle \text{type} \rangle \langle \text{op} \rangle \mid \epsilon$
12.  $\langle \text{dataType} \rangle \rightarrow \text{INTEGER}$
13.  $\langle \text{dataType} \rangle \rightarrow \text{REAL}$
14.  $\langle \text{dataType} \rangle \rightarrow \text{BOOLEAN}$
15.  $\langle \text{dataType} \rangle \rightarrow \text{ARRAY S\&B\&O} \langle \text{range} \rangle \text{S\&B\&C OF} \langle \text{type} \rangle$
16.  $\langle \text{type} \rangle \rightarrow \text{INTEGER}$
17.  $\langle \text{type} \rangle \rightarrow \text{REAL}$
18.  $\langle \text{type} \rangle \rightarrow \text{BOOLEAN}$
19.  $\langle \text{module Def} \rangle \rightarrow \text{START} \langle \text{statements} \rangle \text{END}$
20.  $\langle \text{statements} \rangle \rightarrow \langle \text{statement} \rangle \langle \text{statements} \rangle \mid \epsilon$
21.  $\langle \text{statement} \rangle \rightarrow \langle \text{io Stmt} \rangle$
22.  $\langle \text{statement} \rangle \rightarrow \langle \text{simple Stmt} \rangle$
23.  $\langle \text{statement} \rangle \rightarrow \langle \text{declare Stmt} \rangle$
24.  $\langle \text{statement} \rangle \rightarrow \langle \text{conditional Stmt} \rangle$
25.  $\langle \text{statement} \rangle \rightarrow \langle \text{iterative Stmt} \rangle$
26.  $\langle \text{io Stmt} \rangle \rightarrow \text{GET.VALUE BO ID BC SEMICOL}$
27.  $\langle \text{io Stmt} \rangle \rightarrow \text{PRINT BO} \langle \text{var} \rangle \text{BC SEMICOL}$
28.  $\langle \text{var} \rangle \rightarrow \text{ID} \langle \text{which ID} \rangle$
29.  $\langle \text{var} \rangle \rightarrow \text{NUM}$
30.  $\langle \text{var} \rangle \rightarrow \text{PNUM}$
31.  $\langle \text{var} \rangle \rightarrow \text{TRUE}$
32.  $\langle \text{var} \rangle \rightarrow \text{FALSE}$

MEMBERS

RAJAN -	2019B4A70572P
YASH -	2019B4A70638P
AYUSH -	2019B4A70652P
VASU -	2019B4A70656P
SUDARSHAN -	2019B4A70744P

33.  $\langle \text{which ID} \rangle \rightarrow \text{SQBO } \langle \text{which} \rangle \text{ SQBC} | \epsilon$
34.  $\langle \text{which} \rangle \rightarrow \langle \text{type} \rangle$
35.  $\langle \text{which} \rangle \rightarrow \langle \text{Arithmetic Expression} \rangle$
36.  $\langle \text{type} \rangle \rightarrow \text{NUM}$
37.  $\langle \text{type} \rangle \rightarrow \text{ID}$
38.  $\langle \text{simple Stmt} \rangle \rightarrow \langle \text{assignment Stmt} \rangle$
39.  $\langle \text{simple Stmt} \rangle \rightarrow \langle \text{module Reuse Stmt} \rangle$
40.  $\langle \text{assignment Stmt} \rangle \rightarrow \text{ID } \langle \text{which Stmt} \rangle$
41.  $\langle \text{which Stmt} \rangle \rightarrow \langle \text{2 value ID Stmt} \rangle$
42.  $\langle \text{which Stmt} \rangle \rightarrow \langle \text{2 value ARR Stmt} \rangle$
43.  $\langle \text{2 Value ID Stmt} \rangle \rightarrow \text{ASSIGNOP } \langle \text{expression} \rangle \text{ SEMICOL}$
44.  $\langle \text{2 Value ARR Stmt} \rangle \rightarrow \text{SQBO } \langle \text{index} \rangle \text{ SQBC ASSIGNOP } \langle \text{expression} \rangle \text{ SEMICOL}$
45.  $\langle \text{index} \rangle \rightarrow \langle \text{Arithmetic Expression} \rangle$
46.  $\langle \text{module Reuse Stmt} \rangle \rightarrow \langle \text{optional} \rangle \text{ USE MODULE ID WITH PARAMETERS } \langle \text{id List} \rangle \text{ SEMICOL}$
47.  $\langle \text{optional} \rangle \rightarrow \text{SQBO } \langle \text{id List} \rangle \text{ SQBC ASSIGNOP } | \epsilon$
48.  $\langle \text{id List} \rangle \rightarrow \text{ID } \langle \text{id List}' \rangle$
49.  $\langle \text{id List}' \rangle \rightarrow \text{COMMA ID } \langle \text{id List}' \rangle | \epsilon$
50.  $\langle \text{expression} \rangle \rightarrow \langle \text{Arithmetic Expression} \rangle$
51.  $\langle \text{expression} \rangle \rightarrow \langle \text{boolean Expression} \rangle$
52.  $\langle \text{Arithmetic Expression} \rangle \rightarrow \langle \text{term} \rangle \langle \text{ae} \rangle$
53.  $\langle \text{Arithmetic Expression} \rangle \rightarrow \text{PLUS } \langle \text{new term} \rangle$
54.  $\langle \text{Arithmetic Expression} \rangle \rightarrow \text{MINUS } \langle \text{new term} \rangle$
55.  $\langle \text{ae} \rangle \rightarrow \langle \text{op}' \rangle \langle \text{term} \rangle \langle \text{ae} \rangle | \epsilon$
56.  $\langle \text{term} \rangle \rightarrow \langle \text{factor} \rangle \langle \text{te} \rangle$
57.  $\langle \text{te} \rangle \rightarrow \langle \text{op}'' \rangle \langle \text{factor} \rangle \langle \text{te} \rangle | \epsilon$
58.  $\langle \text{factor} \rangle \rightarrow \text{BO } \langle \text{Arithmetic Expression} \rangle \text{ BC}$
59.  $\langle \text{factor} \rangle \rightarrow \langle \text{var} \rangle$
60.  $\langle \text{var} \rangle \rightarrow \text{ID } \langle \text{which ID} \rangle$
61.  $\langle \text{var} \rangle \rightarrow \text{NUM}$
62.  $\langle \text{var} \rangle \rightarrow \text{RNUM}$
63.  $\langle \text{op}' \rangle \rightarrow \text{PLUS}$
64.  $\langle \text{op}' \rangle \rightarrow \text{MINUS}$
65.  $\langle \text{op}'' \rangle \rightarrow \text{MUL}$
66.  $\langle \text{op}'' \rangle \rightarrow \text{DIV}$
67.  $\langle \text{Arithmetic Expression}' \rangle \rightarrow \langle \text{term}' \rangle \langle \text{ae}' \rangle$
68.  $\langle \text{Arithmetic Expression}' \rangle \rightarrow \text{PLUS } \langle \text{new term}' \rangle$
69.  $\langle \text{Arithmetic Expression}' \rangle \rightarrow \text{MINUS } \langle \text{new term}' \rangle$

- $\langle ae' \rangle \rightarrow \langle op' \rangle \langle term' \rangle \langle ae' \rangle \mid \epsilon$   
 $\langle term' \rangle \rightarrow \langle factor' \rangle \langle te' \rangle$   
 $\langle te' \rangle \rightarrow \langle op'' \rangle \langle factor' \rangle \langle te' \rangle \mid \epsilon$   
 $\langle factor' \rangle \rightarrow BO \langle arithmeticExpression' \rangle BC$   
 $\langle factor' \rangle \rightarrow \langle var''' \rangle$   
 $\langle var''' \rangle \rightarrow ID$   
 $\langle var''' \rangle \rightarrow NUM$   
 $\langle var''' \rangle \rightarrow RNUM$   
 $\langle newterm \rangle \rightarrow ID$   
 $\langle newterm \rangle \rightarrow NUM$   
 $\langle newterm \rangle \rightarrow RNUM$   
 $\langle newterm \rangle \rightarrow BO \langle arithmeticExpression' \rangle BC$   
 $\langle newterm \rangle \rightarrow ID$   
 $\langle newterm \rangle \rightarrow NUM$   
 $\langle newterm \rangle \rightarrow RNUM$   
 $\langle newterm \rangle \rightarrow BO \langle arithmeticExpression' \rangle BC$   
 $\langle booleanExpr \rangle \rightarrow \langle arithmeticExpression \rangle \langle booleanExpr' \rangle$   
 $\langle booleanExpr' \rangle \rightarrow \langle relationalOp \rangle \langle arithmeticExpression \rangle \langle be' \rangle \mid \epsilon$   
 $\langle be' \rangle \rightarrow \langle logicalOp \rangle \langle arithmeticExpression \rangle \langle relationalOp \rangle \langle arithmeticExpression \rangle \langle be' \rangle \mid \epsilon$   
 $\langle booleanExpr \rangle \rightarrow BO \langle booleanExpr' \rangle BC \langle be' \rangle$   
 $\langle be' \rangle \rightarrow \langle logicalOp \rangle BO \langle booleanExpr \rangle BC \langle be' \rangle \mid \epsilon$   
 $\langle be' \rangle \rightarrow TRUE$   
 $\langle be' \rangle \rightarrow FALSE$   
 $\langle be' \rangle \rightarrow ID$   
 $\langle logicalOp \rangle \rightarrow AND \mid OR$   
 $\langle relationalOp \rangle \rightarrow LT$   
 $\langle relationalOp \rangle \rightarrow LE$   
 $\langle relationalOp \rangle \rightarrow GT$   
 $\langle relationalOp \rangle \rightarrow GE$   
 $\langle relationalOp \rangle \rightarrow EQ$   
 $\langle relationalOp \rangle \rightarrow NE$   
 $\langle declareStmt \rangle \rightarrow DECLARE \langle idList \rangle COLON \langle dataType \rangle SEMICOLON$   
 $\langle conditionalStmt \rangle \rightarrow SWITCH BO ID BC START \langle caseStmt \rangle \langle default \rangle END$   
 $\langle caseStmt \rangle \rightarrow CASE \langle int.bool \rangle$

96.  $\langle \text{int}, \text{bool} \rangle \rightarrow \langle \text{int} \rangle$
97.  $\langle \text{int}, \text{bool} \rangle \rightarrow \langle \text{bool} \rangle$
98.  $\langle \text{int} \rangle \rightarrow \text{NUM COLON } \langle \text{Statements} \rangle \text{ BREAK SEMICOL } \langle \text{r-int} \rangle$
99.  $\langle \text{r-int} \rangle \rightarrow \text{CASE } \langle \text{int} \rangle$
100.  $\langle \text{r-int} \rangle \rightarrow \text{DEFAULT}$
101.  $\langle \text{bool} \rangle \rightarrow \langle \text{value} \rangle \text{ COLON } \langle \text{Statements} \rangle \text{ BREAK SEMICOL } \langle \text{r-bool} \rangle$
102.  $\langle \text{r-bool} \rangle \rightarrow \text{CASE } \langle \text{bool} \rangle \mid \epsilon$
103.  $\langle \text{value} \rangle \rightarrow \text{TRUE}$
104.  $\langle \text{value} \rangle \rightarrow \text{FALSE}$
105.  $\langle \text{default} \rangle \rightarrow \text{DEFAULT COLON } \langle \text{Statements} \rangle \text{ BREAK SEMICOL } \mid \epsilon$
106.  $\langle \text{Iterative Stmt} \rangle \rightarrow \text{FOR } \text{BO ID IN } \langle \text{range} \rangle \text{ BC START } \langle \text{Statements} \rangle \text{ END}$
107.  $\langle \text{Iterative Stmt} \rangle \rightarrow \text{WHILE } \text{BO } \langle \text{boolean Expr} \rangle \text{ BC START } \langle \text{Statements} \rangle \text{ END}$
108.  $\langle \text{range} \rangle \rightarrow \text{NUM RANGEOP NUM}$
109.  $\langle \text{range} \rangle \rightarrow \langle \text{typ}' \rangle \text{ RANGEOP } \langle \text{typ}' \rangle$

### Assumptions:

1.  $i = i + 1$  and similar statements are not allowed.
2.  $++a$ ,  $--a$  are not allowed.
3.  $-(-a+b)$  and similar statements are allowed.
4.  $A[+(2 \times 3)]$  indexing is allowed

# FIRST SETS

(5)

$FIRST(\langle start \rangle) = \{DECLARE, DEF, DRIVERDEF\}$

$FIRST(\langle program \rangle) = \{DECLARE, DEF, DRIVERDEF\}$

$FIRST(\langle moduleDeclarations \rangle) = \{DECLARE, \epsilon\}$

$FIRST(\langle moduleDeclaration \rangle) = \{DECLARE\}$

$FIRST(\langle otherModule \rangle) = \{DEF, \epsilon\}$

$FIRST(\langle driverModule \rangle) = \{DRIVERDEF\}$

$FIRST(\langle module \rangle) = \{DEF\}$

$FIRST(\langle ret \rangle) = \{RETURNS, \epsilon\}$

$FIRST(\langle input-list \rangle) = \{ID\}$

$FIRST(\langle ip \rangle) = \{COMMA, \epsilon\}$

$FIRST(\langle output-list \rangle) = \{ID\}$

$FIRST(\langle op \rangle) = \{COMMA, \epsilon\}$

$FIRST(\langle listatype \rangle) = \{INTEGER, REAL, BOOLEAN, ARRAY\}$

$FIRST(\langle type \rangle) = \{INTEGER, REAL, BOOLEAN\}$

$FIRST(\langle moduleDef \rangle) = \{START\}$

$FIRST(\langle statements \rangle) = \{GET-VALUE, PRINT, ID, SQR, USE, DECLARE, SWITCH, FOR, WHILE, \epsilon\}$

$FIRST(\langle Statement \rangle) = \{GET-VALUE, PRINT, ID, SQR, USE, DECLARE, SWITCH, FOR, WHILE\}$

$FIRST(\langle ?o Stmt \rangle) = \{GET-VALUE, PRINT\}$

$FIRST(\langle var \rangle) = \{ID, NUM, RNUM, TRUE, FALSE\}$

$FIRST(\langle which ID \rangle) = \{SQR, \epsilon\}$

$FIRST(\langle which \rangle) = \{NUM, ID, BO, RNUM, PLUS, MINUS\}$

$FIRST(\langle type \rangle) = \{NUM, ID\}$

$FIRST(\langle simple Stmt \rangle) = \{ID, SQR, USE\}$

$FIRST(\langle assignment Stmt \rangle) = \{ID\}$

$FIRST(\langle which Stmt \rangle) = \{ASSIGNOP, SQR, BO\}$

$FIRST(\langle lvalue Id Stmt \rangle) = \{ASSIGNOP\}$

$FIRST(\langle lvalue Arr Stmt \rangle) = \{SQR, BO\}$

$FIRST(\langle ind2v \rangle) = \{NUM, ID, BO, RNUM, PLUS, MINUS\}$

$FIRST(\langle module use Stmt \rangle) = \{SQR, BO, USE\}$



(6)

FIRST(<optional>) = {S000, E}

FIRST(<idList>) = {ID}

FIRST(<idList'>) = {COMMA, E}

FIRST(<expression>) = {BO, ID, NUM, RNUM, PLUS, MINUS, LT, LE, GT, GE, EQ, NE, E, }

FIRST(<arithmeticExpression>) = {BO, ID, NUM, RNUM, PLUS, MINUS}

FIRST(<ae>) = {PLUS, MINUS, E}

FIRST(<term>) = {BO, ID, NUM, RNUM}

FIRST(<te>) = {MUL, DIV, E}

FIRST(<factor>) = {BO, ID, NUM, RNUM}

FIRST(<var>) = {ID, NUM, RNUM}

FIRST(<op'>) = {PLUS, MINUS}

FIRST(<op''>) = {MUL, DIV}

FIRST(<arithmeticExpression'>) = {BO, ID, NUM, RNUM, PLUS, MINUS}

FIRST(<ae'>) = {PLUS, MINUS, E}

FIRST(<term'>) = {BO, ID, NUM, RNUM}

FIRST(<te'>) = {MUL, DIV, E}

FIRST(<factor'>) = {ID, NUM, RNUM, BO}

FIRST(<var'''>) = {ID, NUM, RNUM}

FIRST(<newTerm>) = {ID, NUM, RNUM, BO}

FIRST(<newTerm'>) = {ID, NUM, RNUM, BO}

FIRST(<booleanExpr>) = {LT, LE, GT, GE, EQ, NE, E}

FIRST(<booleanExpr'>) = {LT, LE, GT, GE, EQ, NE, E}

FIRST(<bE>) = {AND, OR, E}

FIRST(<bE'>) = {AND, OR, E, TRUE, FALSE, ID}

FIRST(<logicalOp>) = {AND, OR}

FIRST(<relationalOp>) = {LT, LE, GT, GE, EQ, NE}

FIRST(<declareStmnt>) = {DECLARE}

FIRST(<conditionalStmnt>) = {SWITCH}

FIRST(<caseStmnt>) = {CASE}

FIRST(<int-bool>) = {NUM, TRUE, FALSE}

FIRST(<int>) = {NUM}

FIRST(<rint>) = {CASE, DEFAULT}

(7)

FIRST( $\langle \text{bool} \rangle$ ) = {TRUE, FALSE}

FIRST( $\langle \text{rbool} \rangle$ ) = {CASE,  $\epsilon$ }

FIRST( $\langle \text{value} \rangle$ ) = {TRUE, FALSE}

FIRST( $\langle \text{default} \rangle$ ) = {DEFAULT,  $\epsilon$ }

FIRST( $\langle \text{iterative stmt} \rangle$ ) = {FOR, WHILE}

FIRST( $\langle \text{range} \rangle$ ) = {NUM}

FIRST( $\langle \text{range}' \rangle$ ) = {NUM, 10}

## FOLLOW SETS

(9)

1. FOLLOW ( $\langle \text{moduleDeclarations} \rangle$ ) =  $\{ \text{DEF, DRIVERDEF} \}$
2. FOLLOW ( $\langle \text{otherModules} \rangle$ ) =  $\{ \text{DRIVERDEF, \$} \}$
3. FOLLOW ( $\langle \text{net} \rangle$ ) =  $\{ \text{START} \}$
4. FOLLOW ( $\langle \text{'p'} \rangle$ ) =  $\{ \text{SQBC} \}$
5. FOLLOW ( $\langle \text{program} \rangle$ ) =  $\{ \$ \}$
6. FOLLOW ( $\langle \text{input-plist} \rangle$ ) =  $\{ \text{SQBC} \}$
7. FOLLOW ( $\langle \text{op} \rangle$ ) =  $\{ \text{SQBC} \}$
8. FOLLOW ( $\langle \text{output-plist} \rangle$ ) =  $\{ \text{SQBC} \}$
9. FOLLOW ( $\langle \text{statements} \rangle$ ) =  $\{ \text{END, BREAK} \}$
10. FOLLOW ( $\langle \text{wheris} \rangle$ ) =  $\{ \text{MUL, DIV, PLUS, MINUS, SEMICOL, BC, LT, LE, GT, GE, EQ, NE, AND, OR} \}$
11. FOLLOW ( $\langle \text{var''} \rangle$ ) =  $\{ \text{BC} \}$
12. FOLLOW ( $\langle \text{optional} \rangle$ ) =  $\{ \text{USE} \}$
13. FOLLOW ( $\langle \text{idList'} \rangle$ ) =  $\{ \text{COLON, SEMICOL, SQBC, COMMA} \}$
14. FOLLOW ( $\langle \text{idList} \rangle$ ) =  $\{ \text{COLON, SEMICOL, SQBC, COMMA} \}$
15. FOLLOW ( $\langle \text{Arithmetic Expression} \rangle$ ) =  $\{ \text{SEMICOL, BC, LT, LE, GT, GE, EQ, NE, AND, OR} \}$
16. FOLLOW ( $\langle \text{ae} \rangle$ ) =  $\{ \text{SEMICOL, BC, LT, LE, GT, GE, EQ, NE, AND, OR} \}$
17. FOLLOW ( $\langle \text{be'} \rangle$ ) =  $\{ \text{BC, SEMICOL} \}$
18. FOLLOW ( $\langle \text{boolean Expr} \rangle$ ) =  $\{ \text{BC, SEMICOL} \}$
19. FOLLOW ( $\langle \text{te} \rangle$ ) =  $\{ \text{PLUS, MINUS, SEMICOL, BC, LT, LE, GT, GE, EQ, NE, AND, OR} \}$
20. FOLLOW ( $\langle \text{term} \rangle$ ) =  $\{ \text{PLUS, MINUS, SEMICOL, BC, LT, LE, GT, GE, EQ, NE, AND, OR} \}$
21. FOLLOW ( $\langle \text{wr} \rangle$ ) =  $\{ \text{MUL, DIV, PLUS, MINUS, SEMICOL, BC, LT, LE, GT, GE, EQ, NE, AND, OR} \}$
22. FOLLOW ( $\langle \text{factor} \rangle$ ) =  $\{ \text{MUL, DIV, PLUS, MINUS, SEMICOL, BC, LT, LE, GT, GE, EQ, NE, AND, OR} \}$



23. FOLLOW( $\langle ae' \rangle$ ) = {BC, SABC}
24. FOLLOW( $\langle arithmetic\ Expression' \rangle$ ) = {BC, SABC}
25. FOLLOW( $\langle which' \rangle$ ) = {SABC}
26. FOLLOW( $\langle index' \rangle$ ) = {SABC}
27. FOLLOW( $\langle te' \rangle$ ) = {PLUS, MINUS, SABC, BC}
28. FOLLOW( $\langle term' \rangle$ ) = {PLUS, MINUS, SABC, BC}
29. FOLLOW( $\langle boolean\ Expr' \rangle$ ) = {BC, SEMICOL}
30. FOLLOW( $\langle be' \rangle$ ) = {BC, SEMICOL}
31. FOLLOW( $\langle r\_bool' \rangle$ ) = {DEFAULT, END}
32. FOLLOW( $\langle ind\_bool' \rangle$ ) = {DEFAULT, END}
33. FOLLOW( $\langle case\ Stmt' \rangle$ ) = {DEFAULT, END}
34. FOLLOW( $\langle bool' \rangle$ ) = {DEFAULT, END}
35. FOLLOW( $\langle default' \rangle$ ) = {COLON}