# Compiler Design, Final project, Spring 2024

**Part I.( 20 points)**

Create the following text file: "finalv1.txt"

```
1.          program  s2024;
2.          //This program computes and prints the value
3.               of an expression//
4.         var
5.            // declare variables //
6.            p1 ,      q2s ,      r, pp    : integer ;
7.       begin
8.              p1             = 3 ;
9.                 pp=  23 ;
10.              q2s =         4 ;
11.              r          =  5    ;
12.              p1 =   2*p1+ r*( q2s + pp);
13.         write ( p1 );  // display p1 //
14.
15.              //compute the value of this expression //
16.              pp = p1 * ( q2s + 2 * rc)         ;
17.              write ( "value=",         pp    ) ;  //print the value of pp //
18
19.         end.
```

Apply the following rules to this file and copy the new version in the file "final24.txt" to make it easier to read one token at a time.

a. Any line that begins with // and ends at // are considered as a comment line(s) (i.e. lines #2-3,5,13,15,17), remove them all.
b. Remove all blank line(s) (i.e. line #14, 18)
c. Extra spaces in each line must be removed, leave one space before and one after each token to make tokenization easier.

The "finalf24.txt" should look like this

```
1.          program  s2024;
2.          var
3.          p1 ,  q2s , r , pp : integer ;
4.          begin
5.          p1 = 3 ;
6.          pp=  23 ;
7.          q2s = 4 ;
8.          r  =  5    ;
9.          p1 =   2 * p1 +  r * ( q2s + pp ) ;
10.         write( p1 ) ;  // display p1
11.         pp = p1 * ( q2s + 2 * rc ) ;
17.         write( "value=",  pp    ) ;  //print the value of pp
18.          end.
```

**Part II (50 points)**

Use the following grammar:

| | |
|---|---|
| <prog> | → **program** <identifier>; **var** <dec-list> **begin** <stat-list> **end.** |
| <identifier> | → <letter>{<letter>\|<digit>} note. *This grammar is in EBNF* |
| <dec-list> | → <dec> : <type> ; |
| <dec> | → <identifier> , <dec> \| < identifier > |
| <type> | → **integer** |
| <stat-list> | → <stat> \| <stat> <stat-list> |
| <stat> | → <write> \| <assign> |
| <write> | → **write**( <str> < identifier > ); |
| <str> | →"value=", \| λ |
| <assign> | → < identifier > = <expr>; |
| <expr> | → <expr> + <term> \| <expr> - <term> \| <term> |
| <term> | → <term> * <factor> \| <term> / <factor>\| <factor> |
| <factor> | → < identifier > \| <number> \| ( <expr> ) |
| <number> | → <sign><digit>{ <digit> } note: *the grammar is in EBNF* |
| <sign> | → + \| - \| λ |
| <digit> | → 0\|1\|2\|…\|9 |
| <letter> | → p \| q \| r \| s |

In which **program, var, begin, end. , inetger** , and **write** are reserved words

Have your program (compiler) to check the grammar of the program and display "No Error" if the given program satisfied all grammar's rule, issue "some errors" otherwise.

**Have** your program detect the following errors and issue a corresponding error message:

**program** is expected (if program is missing or spelled wrong)
**var** is expected (if var is missing or spelled wrong)
**begin** is expected (if begin is missing or spelled wrong)
**end.** is expected (if end. is missing or spelled wrong)
**integer** is expected (if integer is missing or spelled wrong)
**write** is expected (if spells wrong)

unknown identifier if the variable is not defined in the declaration block
; ; is missing (if the grammar required a ; )
, is missing (if the grammar equired a , )
. is missing (if the grammar required a .)
( Left parentheses is missing
) Right parentheses is missing

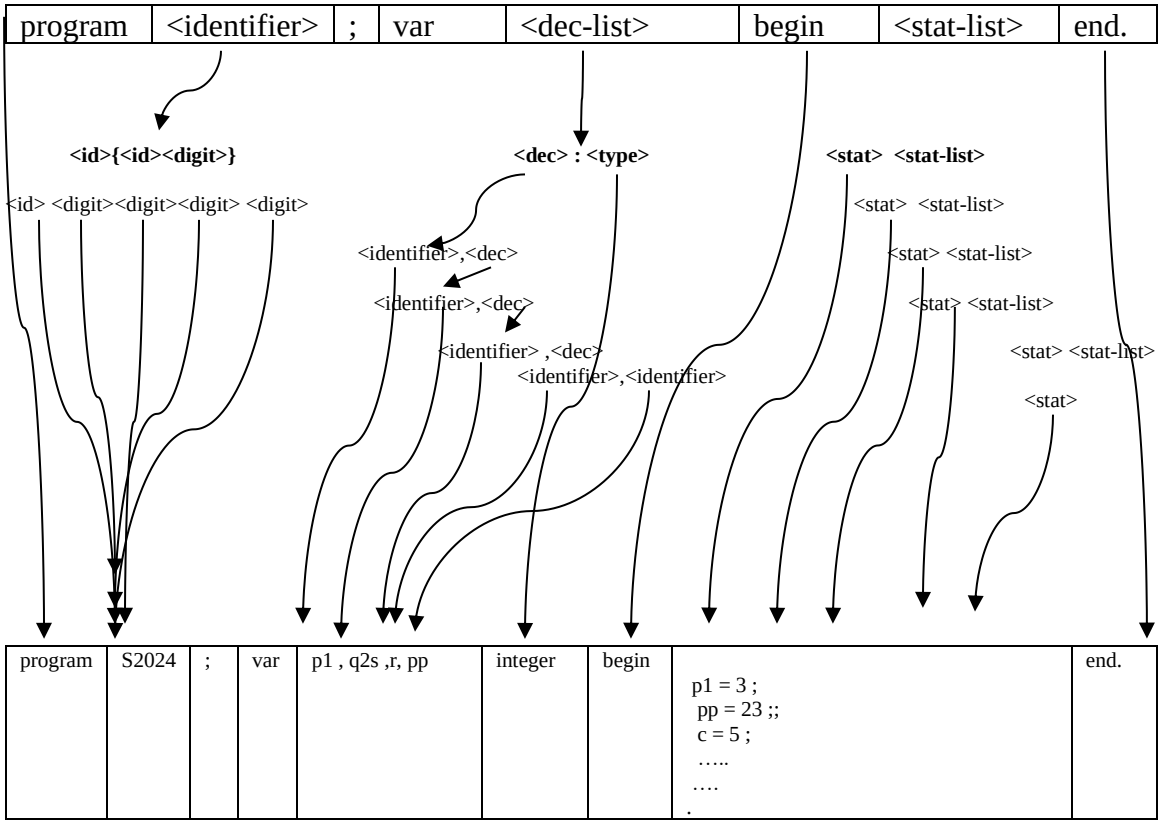
**Output** : Either one of the above messages or **No Error**

**Part III ( 20 points )**

If there are no ERRORS, translate the program to a high level language (C++,C#, Python, or Java). Use the high level language compiler to run your program to display the same output. This is the C++ version of the program in part I

```
#include  <iostream>
using namespace  std;
int main()
{
   int p1 ,  q2s , r , pp ;
   p1 = 3 ;
   pp=  23 ;
  q2s = 4 ;
  r  =  5    ;
  p1 =   2 * p1 +  r * ( q2s + pp ) ;
  cout<< p1 ;
  pp = p1 * ( q2s + 2 * rc ) ;
  cout<< "value=" << pp ;  //print the value of pp
}
```

The whole program grammar consists of ONE line, and each non-terminal in the grammar will be defined over-and-over until hits a terminal.



**(10 points)** Turn in the following in a folder and a flash card which includes the program as well. Everything must be typed (no hand writing is accepted).

1. Cover page:

| |
|---|
| Computer Science xxx<br>Spring 2024<br><br>Final Project<br>Group Members<br>……<br>Method Used:<br><br>Language Used: |

2. The original program on page "1"
3. The original grammar on page "2"
4. The grammar in BNF form (remove all {, } , and | )

| The original grammar in BNF after removing all EBNF grammars. | |
|---|---|
| <prog> | →**program** <identifier>, **var** <dec-list> begin <stat-list> **end.** |
| <identifier> | →<letter> <post-identifier> |
| <post-identifier> | →<letter> <post-identifier> |
| <pos-identifier> | →<digit><post-identifier> |
| <post-identifier> | →$\lambda$ |
| .<br>. | |
| <letter> | p |
| <letter> | q |
| <letter> | r |
| <letter> | s |

5. If you are using predictive parsing table, remove all left recursive rules. If you are using LR parsing table, remove all lambdas. Show the final form of the grammar in BNF

| Final BNF grammar for predictive /LR parsing method | |
|---|---|
| .<br>. | |
| E | →E + T |
| E | →E – T |
| E | →T |
| . | . |
| L | →q |
| L | →r |
| L | →s |

6. List all terminals and non-terminals

| List of non-terminals | | List of terminals |
|---|---|---|
| Old name | New name | + - * …….p q r s |
| <prog> | P | |
| <identifiers> | I | |
| …… | | |
| <expr> | E | |
| <term> | T | |
| ….. | | |
| <digit> | D | |
| <letter> | L | |

7. Find the members of first and follow

| Non-terminals | | FIRST | FOLLOW |
|---|---|---|---|
| P | <prog> | program | $ |
| I | <identifier> | p q r s | p q r s + - / * 0 1 2 …….9 ; , ) |
| …… | …… | …….. | …….. |

8. Show the parsing table

9. Complete copy of the program including all user's defined libraries

   Copy of the sample run for:
   a. The given program in part I
   b. The translated program to a high-level language and its sample run.

Please, turn in all in a folder and insert your flash drive in your folder as well.