**VISVESVARAYA TECHNOLOGICAL UNIVERSITY**

**“JnanaSangama”, Belgaum -590014, Karnataka.**

****

**LAB REPORT**

**on**

**COMPILER DESIGN**

***Submitted by***

**AISHWARYA A G (1BM21CS011)**

***Under the Guidance of***

|  |  |
| --- | --- |
| **Prof. Sunayana S**  **Assistant Professor, BMSCE** |  |

***in partial fulfillment for the award of the degree of***

**BACHELOR OF ENGINEERING**

***in***

**COMPUTER SCIENCE AND ENGINEERING**



**B.M.S. COLLEGE OF ENGINEERING**

**(Autonomous Institution under VTU)**

**BENGALURU-560019**

**November-2023 to March-2024**

**B. M. S. College of Engineering,**

**Bull Temple Road, Bangalore 560019**

(Affiliated To Visvesvaraya Technological University, Belgaum)

**Department of Computer Science and Engineering**



**CERTIFICATE**

This is to certify that the Lab work entitled “**COMPILER DESIGN**” carried out by **AISHWARYA A G (1BM21CS011),** who is bonafide student of **B.M.S. College of Engineering.** It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the academic semester November-2023 to March-2024. The Lab report has been approved as it satisfies the academic requirements in respect of a COMPILER DESIGN **(22CS5PCCPD)** work prescribed for the said degree.

Prof. Lohith J J            Dr. Jyothi S Nayak

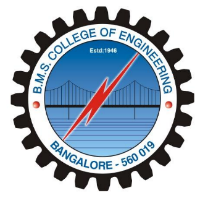
Assistant Professor Professor and Head

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**B. M. S. COLLEGE OF ENGINEERING**

**DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING**



***DECLARATION***

I, AISHWARYA(1BM21CS011), student of 5th Semester, B.E, Department of Computer Science and Engineering, B. M. S. College of Engineering, Bangalore, here by declare that, this lab report entitled " **Compiler Design**" has been carried out by me under the guidance of Prof. Sunayana S, Assistant Professor, Department of CSE, B. M. S. College of Engineering, Bangalore during the academic semester November-2023-February-2024.

I also declare that to the best of my knowledge and belief, the development reported here is not from part of any other report by any other students.

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**Course Outcome**

|  |  |
| --- | --- |
| CO1 | Apply the fundamental concepts for the various phases of compiler design. |
| CO2 | Analyze the syntax and semantic concepts of a compiler. |
| CO3 | Design various types of parsers and Address code generation |
| CO4 | Implement compiler principles, methodologies using lex, yacc tools |

**Part-A: Implementation of Lexical Analyzer, By using C/C++/Java/Python language and using LEX tool.**

**Q1) Write a program to design Lexical Analyzer in C/C++/Java/Python Language (to recognize any five keywords, identifiers, numbers, operators and punctuations)**

CODE :

#include <stdbool.h>

#include <stdio.h>

#include <string.h>

#include <stdlib.h>

bool isDelimiter(char ch)

{

if (ch == ' ' || ch == '+' || ch == '-' || ch == '\*' ||

ch == '/' || ch == ',' || ch == ';' || ch == '>' ||

ch == '<' || ch == '=' || ch == '(' || ch == ')' ||

ch == '[' || ch == ']' || ch == '{' || ch == '}')

return (true);

return (false);

}

bool isOperator(char ch)

{

if (ch == '+' || ch == '-' || ch == '\*' ||

ch == '/' || ch == '>' || ch == '<' ||

ch == '=')

return (true);

return (false);

}

bool validIdentifier(char\* str)

{

if (str[0] == '0' || str[0] == '1' || str[0] == '2' ||

str[0] == '3' || str[0] == '4' || str[0] == '5' ||

str[0] == '6' || str[0] == '7' || str[0] == '8' ||

str[0] == '9' || isDelimiter(str[0]) == true)

return (false);

return (true);

}

bool isKeyword(char\* str)

{

if (!strcmp(str, "if") || !strcmp(str, "else") ||

!strcmp(str, "while") || !strcmp(str, "do") ||

!strcmp(str, "break") ||

!strcmp(str, "continue") || !strcmp(str, "int")

|| !strcmp(str, "double") || !strcmp(str, "float")

|| !strcmp(str, "return") || !strcmp(str, "char")

|| !strcmp(str, "case") || !strcmp(str, "char")

|| !strcmp(str, "sizeof") || !strcmp(str, "long")

|| !strcmp(str, "short") || !strcmp(str, "typedef")

|| !strcmp(str, "switch") || !strcmp(str, "unsigned")

|| !strcmp(str, "void") || !strcmp(str, "static")

|| !strcmp(str, "struct") || !strcmp(str, "goto"))

return (true);

return (false);

}

bool isInteger(char\* str)

{

int i, len = strlen(str);

if (len == 0)

return (false);

for (i = 0; i < len; i++) {

if (str[i] != '0' && str[i] != '1' && str[i] != '2'

&& str[i] != '3' && str[i] != '4' && str[i] != '5'

&& str[i] != '6' && str[i] != '7' && str[i] != '8'

&& str[i] != '9' || (str[i] == '-' && i > 0))

return (false);

}

return (true);

}

bool isRealNumber(char\* str)

{

int i, len = strlen(str);

bool hasDecimal = false;

if (len == 0)

return (false);

for (i = 0; i < len; i++) {

if (str[i] != '0' && str[i] != '1' && str[i] != '2'

&& str[i] != '3' && str[i] != '4' && str[i] != '5'

&& str[i] != '6' && str[i] != '7' && str[i] != '8'

&& str[i] != '9' && str[i] != '.' ||

(str[i] == '-' && i > 0))

return (false);

if (str[i] == '.')

hasDecimal = true;

}

return (hasDecimal);

}

char\* subString(char\* str, int left, int right)

{

int i;

char\* subStr = (char\*)malloc(

sizeof(char) \* (right - left + 2));

for (i = left; i <= right; i++)

subStr[i - left] = str[i];

subStr[right - left + 1] = '\0';

return (subStr);

}

void parse(char\* str)

{

int left = 0, right = 0;

int len = strlen(str);

while (right <= len && left <= right) {

if (isDelimiter(str[right]) == false)

right++;

if (isDelimiter(str[right]) == true && left == right) {

if (isOperator(str[right]) == true)

printf("'%c' IS AN OPERATOR\n", str[right]);

right++;

left = right;

} else if (isDelimiter(str[right]) == true && left != right

|| (right == len && left != right)) {

char\* subStr = subString(str, left, right - 1);

if (isKeyword(subStr) == true)

printf("'%s' IS A KEYWORD\n", subStr);

else if (isInteger(subStr) == true)

printf("'%s' IS AN INTEGER\n", subStr);

//else if (isRealNumber(subStr) == true)

//printf("'%s' IS A REAL NUMBER\n", subStr);

else if (validIdentifier(subStr) == true

&& isDelimiter(str[right - 1]) == false)

printf("'%s' IS A VALID IDENTIFIER\n", subStr);

else if (validIdentifier(subStr) == false

&& isDelimiter(str[right - 1]) == false)

printf("'%s' IS NOT A VALID IDENTIFIER\n", subStr);

left = right;

}

}

return;

}

int main()

{

// maximum length of string is 100 here

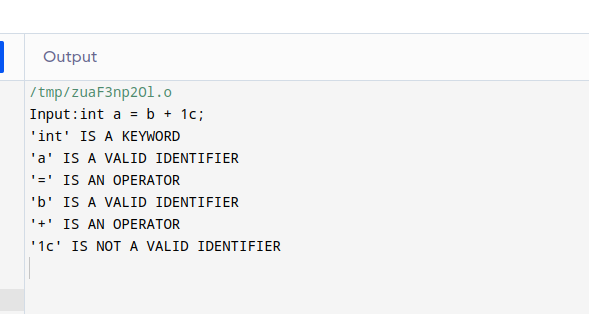
char str[100] = "int a = b + 1c; ";

parse(str); // calling the parse function

return (0);

}

OUTPUT:



**Q2)Write a program in LEX to recognize Floating Point Numbers.**

CODE:

%{

#include<stdio.h>

%}

%%

[+|-]?[0-9]\*[.][0-9]\* {printf("%s is a floating-point number\n",yytext);}

.\* {printf("%s is not a floating-point number\n",yytext);}

%%

int yywrap()

{

}

int main()

{

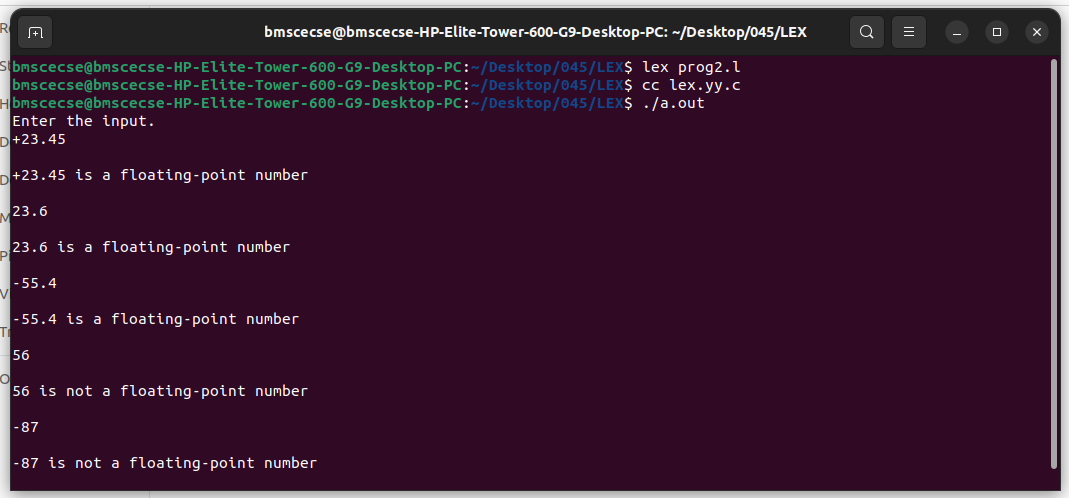
printf("Enter the string : ");

yylex();

return 0;

}

OUTPUT:



**Q3) Write a program in LEX to recognize different tokens: Keywords, Identifiers, Constants, Operators and Punctuation symbols.**

CODE:

%{

#include<stdio.h>

%}

%%

int|char|float|else|for|void|mainz\while {printf("%s is keyword\n",yytext);}

[a-zA-Z\_][a-zA-Z0-9\_]\* {printf("%s is identifier\n",yytext);}

[0-9]\* {printf("%s is a constant\n",yytext);}

[+\*^%/<>&=()|]\* {printf("%s is operator\n",yytext);}

[?|,.'";:]\* {printf("%s is punctuation\n",yytext);}

%%

int yywrap()

{

}

int main()

{

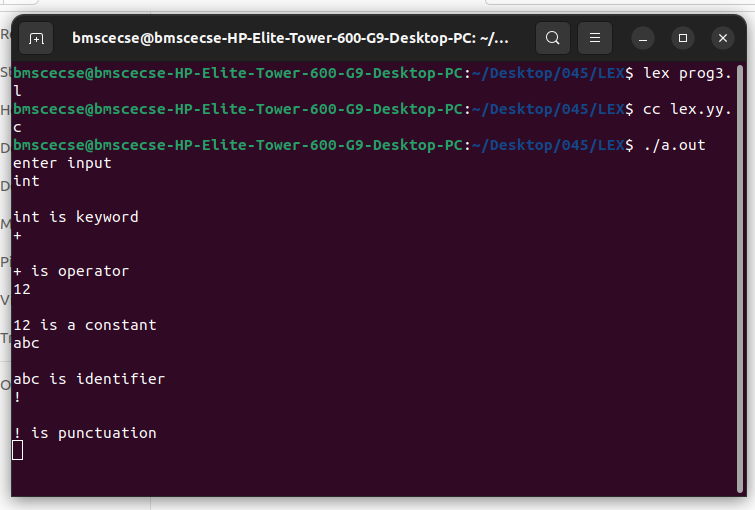
printf("Enter input\n");

yylex();

return 0;

}

OUTPUT:



**Q4) Write a LEX program that copies a file, replacing each nonempty sequence of white spaces by a single blank.**

CODE:

/\*Definition Section\*/

%{

#include<stdio.h>

%}

%%

[\t" "]+ fprintf(yyout," ");

.|\n fprintf(yyout,"%s",yytext);

%%

int yywrap()

{

return 1;

}

int main(void)

{

yyin=fopen("input.txt","r");

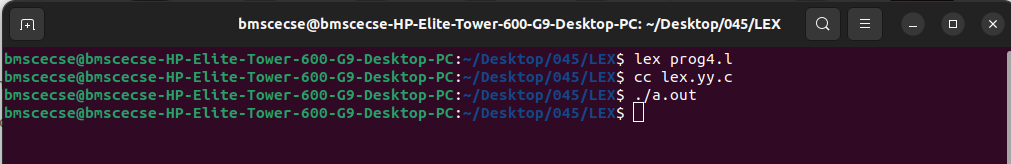
yyout=fopen("output.txt","w");

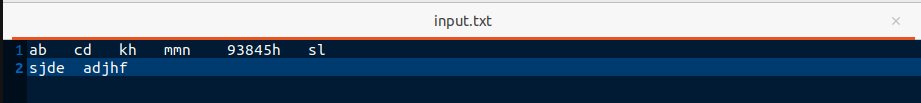
yylex();

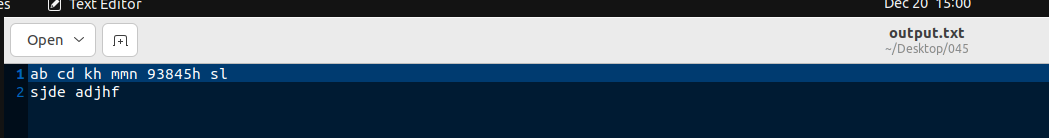
return 0;

}

OUTPUT:







**Q5) Write a LEX program to recognize the following tokens over the alphabets {0,1,..,9}**

**a) The set of all string ending in 00.**

**b) The set of all strings with three consecutive 222’s.**

**c) The set of all string such that every block of five consecutive symbols contains at least two 5’s.**

**d) The set of all strings beginning with a 1 which, interpreted as the binary representation of an integer, is congruent to zero modulo 5.**

**e) The set of all strings such that the 10th symbol from the right end is 1.**

**f) The set of all four digits numbers whose sum is 9**

**g) The set of all four digital numbers, whose individual digits are in ascending order from left to right.**

CODE:

{

int c1=0,c2=0,c3=0,c4=0,c5=0,c6=0,c7=0;

%}

d[0-9]

%%

({d})\*00 {

c1++; printf("%s rule A\n",yytext);

}

({d})\*222({d})\* {

c2++;

printf("%s rule B \n",yytext);

}

(1(0)\*(11|01)(01\*01|00\*10(0)\*(11|1))\*0)(1|10(0)\*(11|01)(01\*01|00\*10(0)\*(11|1))\*10)\* {

c4++;

printf("%s rule D \n",yytext);

}

({d})\*1{d}{9} {

c5++;

printf("%s rule E \n",yytext);

}

{d}{4} {

int sum=0,i;

for(i=0;i<4;i++) {

sum=sum+yytext[i]-48; }

if(sum==9) { c6++; printf("%s rule F \n",yytext);

}

else

{

sum=1;

for(i=0;i<3;i++){

if(yytext[i]>yytext[i+1]) { sum=0;

break;

}

}

if(sum==1) {

c7++;

printf("%s rule G\n",yytext);

}

else { printf("%s doesn't match any rule\n",yytext); }

}

}

({d})\* {

int i,c=0;

if(yyleng<5) { printf("%s doesn't match any rule\n",yytext); }

else

{

for(i=0;i<5;i++) { if(yytext[i]=='5') {

c++; } }

if(c>=2)

{

for(;i<yyleng;i++)

{

if(yytext[i-5]=='5') { c--; }

if(yytext[i]=='5') { c++;

}

if(c<2) { printf("%s doesn't match any rule\n",yytext); break; }

}

if(yyleng==i) { printf("%s rule C\n",yytext); c3++; }

}

else

{

printf("%s doesn't match any rule\n",yytext);

}

}

}

\n {

printf("Total number of tokens matching rules are : \n");

printf("Rule A : %d \n",c1);

printf("Rule B : %d \n",c2);

printf("Rule C : %d \n",c3);

printf("Rule D : %d \n",c4);

printf("Rule E : %d \n",c5);

printf("Rule F : %d \n",c6);

printf("Rule G : %d \n",c7);

}

%%

int yywrap()

{

}

int main()

{

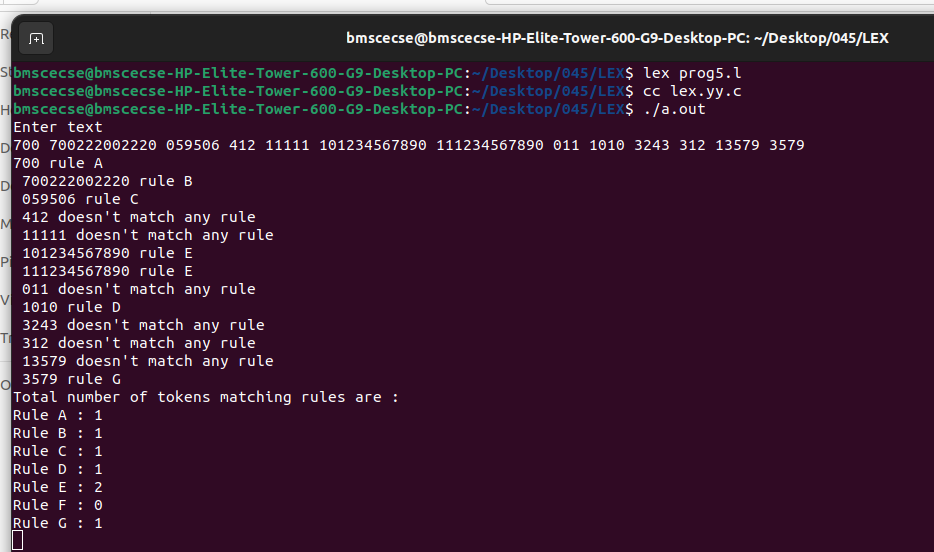
printf("Enter text\n");

yylex();

return 0;

}

OUTPUT:



**Part-B: Part-B: Implementation of Parsers (Syntax Analyzers) Using C/C++/Java/Python language)**

**Q1) Write a program to implement (a) Recursive Descent Parsing with back tracking (Brute Force Method). S→ cAd , A →ab /a**

**CODE:**

#include<stdio.h>

#include<string.h>

int A();

void parse();

char str[15];

int isave,curr\_ptr=0;

int c=1;

int main(void)

{

printf("1.S->cAd\n2.A->ab/a\n");

printf("Enter any string:");

scanf("%s",str);

while(curr\_ptr<strlen(str))

{

if (str[curr\_ptr]=='c')

{

curr\_ptr++;

if (A())

{

curr\_ptr++;

if (str[curr\_ptr]=='d' && str[curr\_ptr+1]=='\0')

{

printf("String is accepted by the grammar\n");

parse();

return 1;

}

else break;

}

else break;

}

else break;

}

printf("String is not accepted by the grammar");

return 0;

}

int A()

{

isave=curr\_ptr;

if (str[curr\_ptr]=='a')

{

curr\_ptr++;

if(str[curr\_ptr]=='b')

{

c=1;

return 1;

}

}

curr\_ptr=isave; //return to start

if(str[curr\_ptr]=='a')

{

c=2;

return 1;

}

else

return 0;

}

void parse(){

printf("The productions used are \n");

printf("S -> cAd\n");

if(c==1)

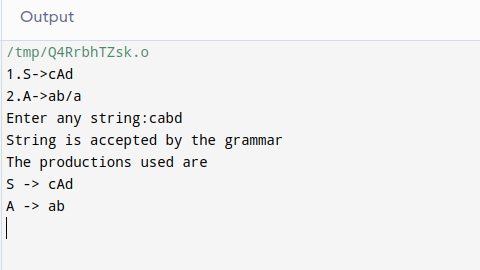
printf("A -> ab\n");

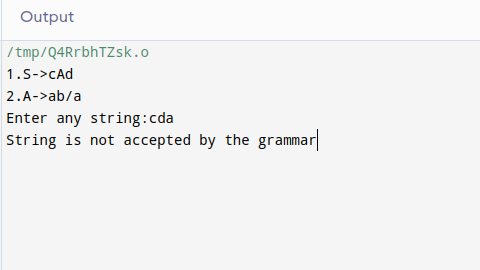
else

printf("A -> a\n");

}

OUTPUT:





**PART-C :Syntax Directed Translation using YACC tool**

**Q1) Design a suitable grammar for evaluation of arithmetic expression having + and – operators. + has least priority and it is left associative - has higher priority and is right associative**

prog.l

%{

#include "y.tab.h"

%}

%%

[0-9]+ {yylval = atoi(yytext);

return NUM;}

[\t] ;

\n return 0;

. return yytext[0];

%%

int yywrap()

{

}

prog.y

%{

/\* Definition section \*/

#include <stdio.h>

%}

%token NUM

%left '+'

%right '-'

/\* Rule Section \*/

%%

expr:e {printf("Valid expression\n");

printf("Result : %d\n",$$);

return 0;}

e: e'+'e {$$=$1+$3;}

| e'-'e {$$=$1-$3;}

| NUM {$$=$1;}

;

%%

int main(){

printf("\nEnter an arithmetic expression\n");

yyparse();

return 0;

}

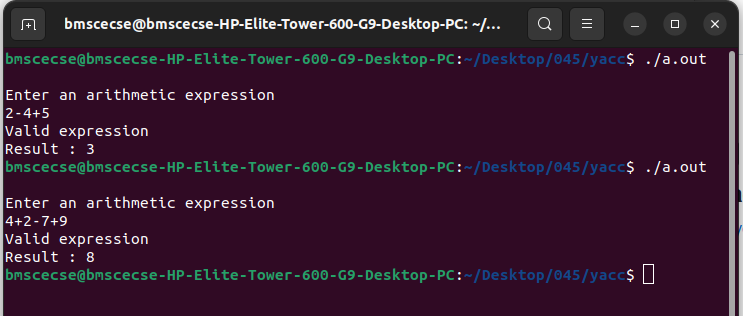
int yyerror(){

printf("\nInvalid expression\n");

return 0;

}

OUTPUT:



**Q2) Use YACC to implement, evaluator for arithmetic expressions (Desktop calculator) .**

prog.l

%{

/\* Definition section \*/

#include<stdio.h>

#include "y.tab.h"

extern int yylval;

%}

/\* Rule Section \*/

%%

[0-9]+ {

yylval=atoi(yytext);

return NUMBER;

}

[\t] ;

[\n] return 0;

. return yytext[0];

%%

int yywrap()

{

return 1;

}

prog.y

%{

/\* Definition section \*/

#include<stdio.h>

int flag=0;

%}

%token NUMBER

%right '^'

%left '+' '-'

%left '\*' '/' '%'

%left '(' ')'

/\* Rule Section \*/

%%

expr:E {printf("Valid expression\n");

printf("Result : %d\n",$$);

return 0;}

E:E'+'E {$$=$1+$3;}

|E'-'E {$$=$1-$3;}

|E'\*'E {$$=$1\*$3;}

|E'/'E {$$=$1/$3;}

|E'%'E {$$=$1%$3;}

|E'^'E {$$=$1^$3;}

|'('E')' {$$=$2;}

| NUMBER {$$=$1;}

;

%%

//driver code

void main()

{

printf("\nEnter Any Arithmetic Expression:\n");

yyparse();

if(flag==0)

printf("\nEntered arithmetic expression is Valid\n\n");

}

void yyerror()

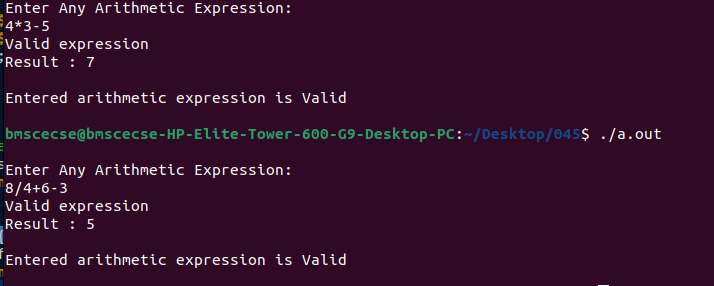
{

printf("\nEntered arithmetic expression is Invalid\n\n");

flag=1;

}

OUTPUT:



**Q3) Use YACC to generate Syntax tree for a given expression.**

prog.l

%{

#include "y.tab.h"

extern int yylval;

%}

%%

[0-9]+ { yylval = atoi(yytext);

return digit; }

[\t] ;

[\n] return 0;

. return yytext[0];

%%

int yywrap(){

}

prog.y

%{

#include <math.h>

#include<ctype.h>

#include<stdio.h>

#include<stdlib.h>

#include<string.h>

struct tree\_node

{

char val[10];

int lc;

int rc;

};

int ind;

struct tree\_node syn\_tree[100];

void my\_print\_tree(int cur\_ind);

int mknode(int lc,int rc,char val[10]);

%}

%token digit

%right '^'

%left '+' '-'

%left '\*' '/' '%'

%%

S:E { my\_print\_tree($1); }

;

E:E'+'T { $$= mknode($1,$3,"+"); ; }

|T { $$=$1; }

;

E:E'-'T { $$= mknode($1,$3,"-"); ; }

|T { $$=$1; }

;

T:T'\*'F { $$= mknode($1,$3,"\*"); ; }

|F {$$=$1 ; }

;

T:T'/'F { $$= mknode($1,$3,"/"); ; }

|F {$$=$1 ; }

;

F:'('E')' { $$=$2; }

|digit {char buf[10]; printf(buf,"%d", yylval); $$ = mknode(-1,-1,buf);}

%%

int main()

{

ind=0;

printf("Enter an expression\n");

yyparse();

return 0;

}

int yyerror()

{

printf("NITW Error\n");

}

int mknode(int lc,int rc,char val[10])

{

strcpy(syn\_tree[ind].val,val);

syn\_tree[ind].lc = lc;

syn\_tree[ind].rc = rc;

ind++;

return ind-1;

}

/\*my\_print\_tree function to print the syntax tree in DLR fashion\*/

void my\_print\_tree(int cur\_ind)

{

if(cur\_ind==-1) return;

if(syn\_tree[cur\_ind].lc==-1 && syn\_tree[cur\_ind].rc==-1)

printf("Digit Node -> Index : %d, Value : %s\n",cur\_ind,syn\_tree[cur\_ind].val);

else

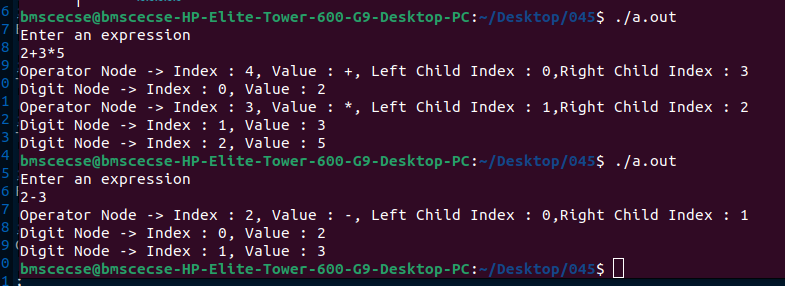
printf("Operator Node -> Index : %d, Value : %s, Left Child Index : %d,Right Child Index : %d\n",cur\_ind,syn\_tree[cur\_ind].val, syn\_tree[cur\_ind].lc,syn\_tree[cur\_ind].rc);

my\_print\_tree(syn\_tree[cur\_ind].lc);

my\_print\_tree(syn\_tree[cur\_ind].rc);

}

OUTPUT:



**Q4) Use YACC to convert: Infix expression to Postfix expression.**

prog.l

%{

#include "y.tab.h"

extern int yylval;

%}

%%

[0-9]+ { yylval=atoi(yytext); return digit;}

[\t] ;

[\n] return 0;

. return yytext[0];

%%

int yywrap()

{

}

prog.y

%{

#include <ctype.h>

#include<stdio.h>

#include<stdlib.h>

%}

%token digit

%right '^'

%left '+' '-'

%left '\*' '/'

%%

S: E {printf("\n\n");}

;

E: E '+' T { printf ("+");}

| T

;

E: E '-' T { printf ("-");}

| T

;

T: T '\*' F { printf("\*");}

| F

;

T: T '/' F { printf("/");}

| F

;

F: F '^' G { printf("^");}

| G

;

G: '(' E ')'

| digit {printf("%d", $1);}

;

%%

int main()

{

printf("Enter infix expression: ");

yyparse();

}

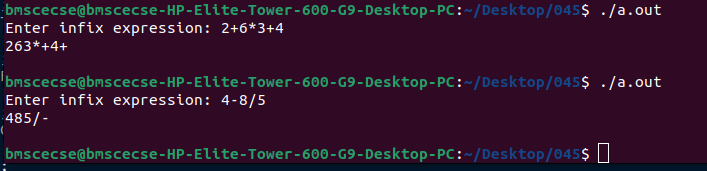
yyerror()

{

printf("Error");

}

OUTPUT:



**Q5) Use YACC to generate 3-Address code for a given expression.**

prog.l

d [0-9]+

a [a-zA-Z]+

%{

#include<stdio.h>

#include<stdlib.h>

#include"y.tab.h"

extern int yylval;

extern char iden[20];

%}

%%

{d} { yylval=atoi(yytext); return digit; }

{a} { strcpy(iden,yytext); yylval=1; return id;}

[ \t] {;}

\n return 0;

. return yytext[0];

%%

int yywrap()

{

}

prog.y

%{

#include <math.h>

#include<ctype.h>

#include<stdio.h>

int var\_cnt=0;

char iden[20];

%}

%token id

%token digit

%%

S:id '=' E { printf("%s=t%d\n",iden,var\_cnt-1); }

E:E '+' T { $$=var\_cnt; var\_cnt++; printf("t%d = t%d + t%d;\n", $$, $1, $3 );

}

|E '-' T { $$=var\_cnt; var\_cnt++; printf("t%d = t%d - t%d;\n", $$, $1, $3 );

}

|T { $$=$1; }

;

T:T '\*' F { $$=var\_cnt; var\_cnt++; printf("t%d = t%d \* t%d;\n", $$, $1, $3 ); }

|T '/' F { $$=var\_cnt; var\_cnt++; printf("t%d = t%d / t%d;\n", $$, $1, $3 ); }

|F {$$=$1 ; }

F:P '^' F { $$=var\_cnt; var\_cnt++; printf("t%d = t%d ^ t%d;\n", $$, $1, $3 );}

| P { $$ = $1;}

;

P: '(' E ')' { $$=$2; }

|digit { $$=var\_cnt; var\_cnt++; printf("t%d = %d;\n",$$,$1); }

;

%%

int main()

{

var\_cnt=0;

printf("Enter an expression : \n");

yyparse();

return 0;

}

yyerror()

{

printf("error");

}

OUTPUT:

