

COMPILER DESIGN

LAB MANUAL

Subject Code: **CS 431**
Regulations: **APJKTU**
Class: **CSE**
Year: **IV Year**
Semester: **VII Semester**

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COMPUTER SCIENCE AND ENGINEERING

Program Outcomes

PO1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	Design/ development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes

PSO1	Professional Skills: The ability to research, understand and implement computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient analysis and design of computer-based systems of varying complexity.
PSO2	Problem-Solving Skills: The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.
PSO3	Successful Career and Entrepreneurship: The ability to employ modern computer languages, environments, and platforms in creating innovative career paths, to be an entrepreneur, and a zest for higher studies.

Note 1:

A simple program written in this language is

```
{
int a[3],t1,t2;
t1=2;
a[0]=1;a[1]=2;a[t]=3;
t2=-( a[2]+t1*6)/(a[2]-t1);
If t2>5then
print(t2)
else{
int t3;
t3=99;
t2=25;
print(-t1+t2*t3);/*this is a comment on 2 lines*/
}endif
}
```

Comments(zero or more characters enclosed between the standard C/JAVA Style comment brackets/*...*/)can be inserted .The language has rudimentary support for 1-dimensional array, the declaration `int a[3]` declares an array of three elements, referenced as `a[0]`, `a[1]` and `a[2]`. Note also you should worry about the scoping of names.

Note 2:

Consider the following mini language, a simple procedural high –level language, only operating on integer data, with a syntax looking vaguely like a simple C crossed with pascal. The syntax of the language is defined by the following grammar.

```
<program>::=<block>
<block>::={<variable definition><slist>}{<slist>}
<variabledefinition>::=int <vardeflist>
<vardec>::=<identifier>|<identifier>[<constant>]
<slist>::=<statement>|<statement>;<slist>
<statement>::=<assignment>|<ifstatement>|<whilestatement>|<block>|<printstatement>|<empty>
<assignment>::=<identifier>=<expression>|<identifier>[<expression>]=<expression>
<if statement>::=if<bexpression>then<slist>else<slist>endifif<bexpression>then<slisi>endif
<whilestatement>::=while<bexpression>do<slisi>enddo
<printstatement>::=print(<expression>)
<expression>::=<expression>::=<expression><addingop><term>|<term>|<addingop><term>
<bexprssion>::=<expression><relop><expression>
<relop>::=<|<=<|==<|>=<|>|!=
<addingop>::=+|-
<term>::=<term><multop><factor>|<factor>
<Multop>::=*/
<factor>::=<constant>|<identifier>|<identifier>[<expression>]|(<expression>)
<constant>::=<digit>|<digit><constant><identifier>::=<identifier><letter or digit>|<letter>
<letter or digit>::=<letter>|<digit>
<letter>::=a|b|c|d|e|f|g|h|i|j|k|l|m|n|o|p|q|r|s|t|u|v|w|x|y|z
<digit>::=0|1|2|3|4|5|6|7|8|9
<empty>::=has the obvious meaning
```

COMPILER DESIGN LABORATORY

OBJECTIVE:

This laboratory course is intended to make the students experiment on the basic techniques of compiler construction and tools that can be used to perform syntax-directed translation of a high-level programming language into an executable code. Students will design and implement language processors in C by using tools to automate parts of the implementation process. This will provide deeper insights into the more advanced semantics aspects of programming languages, code generation, machine independent optimizations, dynamic memory allocation, and object orientation.

OUTCOMES:

Upon the completion of Compiler Design practical course, the student will be able to:

1. Understand the working of lex and yacc compiler for debugging of programs.
2. Understand and define the role of lexical analyzer, use of regular expression and transition diagrams.
3. Understand and use Context free grammar, and parse tree construction.
4. Learn & use the new tools and technologies used for designing a compiler.
5. Develop program for solving parser problems.
6. Learn how to write programs that execute faster.

COMPILER DESIGN LAB SYLLABUS

Course code	L-T-P -Credits	Course Name	Year of Introduction
CS431	0-0-3-1	COMPILER DESIGN LAB	2016
Pre-requisite : CS331 System Software Lab			
<p>Course Objectives:</p> <p>To implement the different Phases of compiler.</p> <p>To implement and test simple optimization techniques.</p> <p>To give exposure to compiler writing tools.</p>			
<p>List of Exercises/Experiments :</p> <ol style="list-style-type: none"> Design and implement a lexical analyzer for given language using C and the lexical analyzer should ignore redundant spaces, tabs and new lines. Implementation of Lexical Analyzer using Lex Tool Generate YACC specification for a few syntactic categories. <ol style="list-style-type: none"> Program to recognize a valid arithmetic expression that uses operator +, −, * and /. Program to recognize a valid variable which starts with a letter followed by any number of letters or digits. Implementation of Calculator using LEX and YACC Convert the BNF rules into YACC form and write code to generate abstract syntax tree Write program to find ϵ – closure of all states of any given NFA with ϵ transition. Write program to convert NFA with ϵ transition to NFA without ϵ transition. Write program to convert NFA to DFA Write program to minimize any given DFA. Develop an operator precedence parser for a given language. Write program to find Simulate First and Follow of any given grammar. Construct a recursive descent parser for an expression. Construct a Shift Reduce Parser for a given language. Write a program to perform loop unrolling. Write a program to perform constant propagation. Implement Intermediate code generation for simple expressions. Implement the back end of the compiler which takes the three address code and produces the 8086 assembly language instructions that can be assembled and run using an 8086 assembler. The target assembly instructions can be simple move, add, sub, jump etc. <p>Expected Outcome:</p> <p>The Student will be able to :</p> <ol style="list-style-type: none"> Implement the techniques of Lexical Analysis and Syntax Analysis. Apply the knowledge of Lex & Yacc tools to develop programs. Generate intermediate code. Implement Optimization techniques and generate machine level code. 			

List of Experiments

Sl.No.	Description	Page No
1	Design a lexical analyzer for given language and the lexical analyzer should ignore redundant spaces, tabs and new lines. It should also ignore comments. Although the syntax specification states that identifiers can be arbitrarily long, you may restrict the length to some reasonable value. Simulate the same in C language.	8
2	Write a C program to identify whether a given line is a comment or not	12
3	Write a C program to recognize strings under 'a', 'a*b+', 'abb'.	14
4	Write a C program to test whether a given identifier is valid or not.	16
5	Write a C program to simulate lexical analyzer for validating operators.	17
6	Implement the lexical analyzer using JLex, flex or other lexical analyzer generating tools.	19
7	Write a C program for implementing the functionalities of predictive parser for the mini language specified in Note 1.	21
8	(a) Write a C program for constructing of LL (1) parsing.	24
	(b) Write a C program for constructing recursive descent parsing.	27
9	Write a C program to implement LALR parsing	30
10	a) Write a C program to implement operator precedence parsing.	36
	b) Write a C program to implement Program semantic rules to calculate the expression that takes an expression with digits, + and * and computes the value. Convert the BNF rules into yacc form and write code to generate abstract syntax tree for the mini language specified in Note 1.	40
11	Write a C program to generate machine code from abstract syntax tree generated by the parser. The instruction set specified in Note 2 may be considered as the target code.	42
12	Write a C program to generate machine code from abstract syntax tree generated by the parser. The instruction set specified in Note 2 may be considered as the target code.	49

EXPERIMENT- 1

1.1

OBJECTIVE:

Design a lexical analyzer for given language and the lexical analyzer should ignore redundant spaces, tabs and new lines. It should also ignore comments. Although the syntax specification states that identifiers can be arbitrarily long, you may restrict the length to some reasonable value. Simulate the same in C language.

1.2

RESOURCE: C ++

1.3

PROGRAM LOGIC:

1. Read the input Expression
2. Check whether input is alphabet or digits then store it as identifier
3. If the input is operator store it as symbol
4. Check the input for keywords

1.4

PROCEDURE:

Go to debug -> run or press CTRL + F9 to run the program.

1.5 PROGRAM:

```
#include<string.h>
#include<ctype.h>
#include<stdio.h>
void keyword(char str[10])
{
if(strcmp("for",str)==0||strcmp("while",str)==0||strcmp("do",str)==0||strcmp("int",str)==0||str
cmp("float",str)==0||strcmp("char",str)==0||strcmp("double",str)==0||strcmp("static",str)==0||strcmp
("switch",str
)==0||strcmp("case",str)==0)
printf("\n%s is a keyword",str);
else
printf("\n%s is an identifier",str);
}
main()
{
FILE *f1,*f2,*f3;
char c,str[10],st1[10];
int num[100],lineno=0,tokenvalue=0,i=0,j=0,k=0;
printf("\nEnter the c program");/*gets(st1);*/
f1=fopen("input","w");
while((c=getchar())!=EOF)
putc(c,f1);
fclose(f1);
f1=fopen("input","r");
f2=fopen("identifier","w");
f3=fopen("specialchar","w");
while((c=getc(f1))!=EOF) {
if(isdigit(c))
{
```



```

tokenvalue=c-'0';
1c=getc(f1);
while(isdigit(c))
tokenvalue*=10+c-'0';
c=getc(f1);
}
num[i++]=tokenvalue;
ungetc(c,f1);
{
}
else
if(isalpha(c))
{
putc(c,f2);
c=getc(f1);
while(isdigit(c)||isalpha(c)||c=='_'||c=='$')
{
putc(c,f2);
c=getc(f1);
}
putc(' ',f2);
ungetc(c,f1);
}
else
if(c==' '||c=='\t')
printf(" ");
else
if(c=='\n')
lineno++;
else
putc(c,f3);
}
fclose(f2);
fclose(f3);
fclose(f1);
printf("\nThe no's in the program are");
for(j=0;j<i;j++)
printf("%d",num[j]);
printf("\n");
f2=fopen("identifier","r");
k=0;
printf("The keywords and identifiers are:");
while((c=getc(f2))!=EOF)
{
if(c!=' ')
str[k++]=c;
else
{
str[k]='\0';
keyword(str);

```

```

k=0;
}
2}
fclose(f2);
f3=fopen("specialchar","r");
printf("\nSpecial characters are");
while((c=getc(f3))!=EOF)
printf("%c",c);
printf("\n");
fclose(f3);
printf("Total no. of lines are:%d",lineno);
}

```

1.6

PRE LAB QUESTIONS

- 1.What is token?
- 2.What is lexeme?
- 3.What is the difference between token and lexeme?
- 4.Define phase and pass?
- 5.What is the difference between phase and pass?
- 6.What is the difference between compiler and interpreter?

1.7

LAB ASSIGNMENT

1. Write a program to recognize identifiers.
2. Write a program to recognize constants.
3. Write a program to recognize keywords and identifiers.
4. Write a program to ignore the comments in the given input source program.

1.8

POST LAB QUESTIONS

1. What is lexical analyzer?
2. Which compiler is used for lexical analyzer?
3. What is the output of Lexical analyzer?
4. What is LEX source Program?

1.9

INPUT & OUTPUT:

Input:

Enter Program \$ for termination:

```

{
int a[3],t1,t2;
t1=2; a[0]=1; a[1]=2; a[t1]=3;
t2=-(a[2]+t1*6)/(a[2]-t1);
if t2>5 then
print(t2);
else {
int t3;
t3=99;
t2=-25;
print(-t1+t2*t3); /* this is a comment on 2 lines */
} endif
}
$

```

Output:

Variables : a[3] t1 t2 t3

Operator : - + * / >

Constants : 2 1 3 6 5 99 -25

Keywords : int if then else endif

Special Symbols : , ; () { }

Comments : this is a comment on 2 lines

EXPERIMENT-2

2.1 OBJECTIVE:

* Write a C program to identify whether a given line is a comment or not.

2.2 RESOURCE: Turbo C++

2.3 PROGRAM LOGIC:

Read the input string.

Check whether the string is starting with '/' and check next character is '/' or '*'.

If condition satisfies print comment. Else not a comment.

2.4 PROCEDURE:

Go to debug -> run or press CTRL + F9 to run the program.

2.5

PROGRAM:

```
#include<stdio.h>
#include<conio.h>
void main()
{
char com[30];
int i=2,a=0;
clrscr();
printf("\n Enter comment:");
gets(com);
if(com[0]=='/') {
if(com[1]=='/')
printf("\n It is a comment");
else if(com[1]=='*') {
for(i=2;i<=30;i++)
{
if(com[i]=='*'&&com[i+1]=='/')
{
printf("\n It is a comment");
a=1;
break; }
else
continue; }
if(a==0)
printf("\n It is not a comment");
}
else
printf("\n It is not a comment");
}
else
printf("\n It is not a comment");
getch(); }
```

2.6

INPUT & OUTPUT:

Input: Enter comment: //hello

Output: It is a comment

Input: Enter comment: hello
Output: It is not a comment

EXPERIMENT-3

3.1

OBJECTIVE:

Write a C program to recognize strings under 'a', 'a*b+', 'abb'.

3.2

RESOURCE: C++

3.3

PROGRAM LOGIC:

By using transition diagram we verify input of the state. If the state recognize the given pattern rule. Then print string is accepted under a*/ a*b+/ abb. Else print string not accepted.

3.4

PROCEDURE: Go to debug -> run or press CTRL + F9 to run the program.

3.5

PROGRAM:

```
#include<stdio.h>
#include<conio.h>
#include<string.h>
#include<stdlib.h>
void main()
{
char s[20],c;
int state=0,i=0;
clrscr();
printf("\n Enter a string:");
gets(s);
while(s[i]!='\0')
{
switch(state)
{
case 0: c=s[i++];
if(c=='a')
state=1;
else if(c=='b')
state=2;
else
state=6;
break;
case 1: c=s[i++];
if(c=='a')
state=3;
5else if(c=='b')
state=4;
else
state=6;
break;
case 2: c=s[i++];
if(c=='a')
state=6;
else if(c=='b')
state=2;
```

```

else
state=6;
break;
case 3: c=s[i++];
if(c=='a')
state=3;
else if(c=='b')
state=2;
else
state=6;
break;
case 4: c=s[i++];
if(c=='a')
state=6;
else if(c=='b')
state=5;
else
state=6;
break;
case 5: c=s[i++];
if(c=='a')
state=6;
else if(c=='b')
state=2;
else
state=6;
break;
case 6: printf("\n %s is not recognised.",s);
exit(0);
}
}
f(state==1)
printf("\n %s is accepted under rule 'a'",s);
else if((state==2)||(state==4))
printf("\n %s is accepted under rule 'a*b'",s);
else if(state==5)
printf("\n %s is accepted under rule 'abb'",s);
getch();
}

```

3.6

INPUT & OUTPUT:

Input :

Enter a String: aaaabbbbb

Output:

aaaabbbbb is accepted under rule 'a*b+'

Enter a string: cdgs

cdgs is not recognized

EXPERIMENT-4

4.1

OBJECTIVE:

*Write a C program to test whether a given identifier is valid or not

4.2

RESOURCE: C++

4.3

PROGRAM LOGIC:

Read the given input string. Check the initial character of the string is numerical or any special character except '_' then print it is not a valid identifier. Otherwise print it as valid identifier if remaining characters of string doesn't contains any special characters except '_'.

4.4

PROCEDURE:

Go to debug -> run or press CTRL + F9 to run the program.

4.5

PROGRAM:

```
#include<stdio.h>
#include<conio.h>
#include<ctype.h>
void main()
{
    char a[10];
    int flag, i=1;
    clrscr();
    printf("\n Enter an identifier:");
    gets(a);
    if(isalpha(a[0]))
        flag=1;
    else
        printf("\n Not a valid identifier");
    while(a[i]!='\0')
    {
        if(!isdigit(a[i])&&!isalpha(a[i]))
        {
            flag=0;
            break;
        }
        i++;
    }
    if(flag==1)
        printf("\n Valid identifier");
    getch();
}
```

4.6

INPUT & OUTPUT:

Input: Enter an identifier: first

Output:

Valid identifier

Enter an identifier: laqw

Not a valid identifier

EXPERIMENT-5

5.1

OBJECTIVE:

*Write a C program to simulate lexical analyzer for validating operators.

5.2

RESOURCE: C++

5.3

PROGRAM LOGIC :

Read the given input. If the given input matches with any operator symbol. Then display in terms of words of the particular symbol. Else print not a operator.

5.4

PROCEDURE:

Go to debug -> run or press CTRL + F9 to run the program.

5.5

PROGRAM:

```
#include<stdio.h>
#include<conio.h>
void main()
{
char s[5];
clrscr();
printf("\n Enter any operator:");
gets(s);
switch(s[0])
{
case '>': if(s[1]=='=')
printf("\n Greater than or equal");
else
printf("\n Greater than");
break;
case '<': if(s[1]=='=')
printf("\n Less than or equal");
else
printf("\n Less than");
break;
case '=': if(s[1]=='=')
printf("\n Equal to");
else
printf("\n Assignment");
break;
case '!': if(s[1]=='=')
printf("\n Not Equal");
else
printf("\n Bit Not");
break;
case '&': if(s[1]=='&')
printf("\n Logical AND");
else
printf("\n Bitwise AND");
break;
```

```

case '|': if(s[1]=='|')
printf("\nLogical OR");
9else
printf("\nBitwise OR");
break;
case '+': printf("\n Addition");
break;
case '-': printf("\nSubstraction");
break;
case '*': printf("\nMultiplication");
break;
case '/': printf("\nDivision");
break;
case '%': printf("Modulus");
break;
default: printf("\n Not a operator");
}
getch();
}

```

5.6

INPUT & OUTPUT:

Input

Enter any operator: *

Output

Multiplication

EXPERIMENT-6

6.1 OBJECTIVE:

Implement the lexical analyzer using JLex, flex or other lexical analyzer generating tools.

6.2 RESOURCE: Linux using Putty

6.3 PROGRAM LOGIC:

Read the input string.

Check whether the string is identifier/ keyword /symbol by using the rules of identifier and keywords

using LEX Tool

6.4 PROCEDURE:

Go to terminal .Open vi editor ,Lex lex.l , cc lex.yy.c , ./a.out

6.5 PROGRAM:

```
/* program name is lexp.l */
% {
/* program to recognize a c program */
int COMMENT=0;
% }
identifier [a-zA-Z][a-zA-Z0-9]*
%%
#.* { printf("\n%s is a PREPROCESSOR DIRECTIVE",yytext);}
int |float |char |double |while |for |do |if |break |continue |void |switch |case |long |struct |const
|typedef |
return
|else |goto { printf("\n\t%s is a KEYWORD",yytext);}
"/" { COMMENT = 1;}
/* { printf("\n\t%s is a COMMENT\n",yytext);} */
"*/" { COMMENT = 0;}
/* printf("\n\t%s is a COMMENT\n",yytext);} */
{ identifier } \ ( { if(!COMMENT) printf("\n\nFUNCTION\n\t%s",yytext);}
{ { if(!COMMENT) printf("\n BLOCK
BEGINS"); } } { if(!COMMENT) printf("\n
BLOCK ENDS"); }
{ identifier } \ ( [[0-9]*\)]? { if(!COMMENT) printf("\n %s
IDENTIFIER",yytext);} ".*" { if(!COMMENT) printf("\n\t%s is a
STRING",yytext);}
[0-9]+ { if(!COMMENT) printf("\n\t%s is a
NUMBER",yytext);} { if(!COMMENT)
printf("\n\t"); ECHO; printf("\n"); }
( ECHO;
{ if(!COMMENT) printf("\n\t%s is an ASSIGNMENT OPERATOR",yytext);}
<= >= < > { if(!COMMENT) printf("\n\t%s is a RELATIONAL OPERATOR",yytext);}
%%
int main(int argc, char **argv)
{
if (argc > 1)
{
FILE *file;
file =
fopen(argv[1], "r");
if(!file)
```

```

{
printf("could not open %s
\n",argv[1]); exit(0);
}
yyin = file;
}
yylex();
11printf("\n\n");
return 0;
} int yywrap()
{
return 0;
}

```

6.6 PRE LAB QUESTIONS:

- 1.List the different sections available in LEX compiler?
- 2.What is an auxiliary definition?
- 3.How can we define the translation rules?
- 4.What is regular expression?
- 5.What is finite automaton?

6.7 LAB ASSIGNMENT:

- 1.Write a program that defines auxiliary definitions and translation rules of Pascal tokens?
- 2.Write a program that defines auxiliary definitions and translation rules of C tokens?
- 3.Write a program that defines auxiliary definitions and translation rules of JAVA tokens

6.8 POST LAB QUESTIONS:

- 1.What is Jlex?
- 2.What is Flex?
- 3.What is lexical analyzer generator?
- 4.What is the input for LEX Compiler?
- 5.What is the output of LEX compiler?

6.6 INPUT & OUTPUT:

Input

```

$gedit var.c
#include<stdio.h>
main()
{
int a,b;
}

```

Output

```

$lex lex.l
$cc lex.yy.c
$./a.out var.c
#include<stdio.h> is a PREPROCESSOR DIRECTIVE
FUNCTION
main (
)
BLOCK BEGINS
int is a KEYWORD
a IDENTIFIER
b IDENTIFIER
BLOCK ENDS

```

EXPERIMENT-7

7.1 OBJECTIVE:

Write a C program for implementing the functionalities of predictive parser for the mini language specified in Note 1.

7.2 RESOURCE: C++

7.3 PROGRAM LOGIC:

Read the input string.

By using the FIRST AND FOLLOW values.

Verify the FIRST of non terminal and insert the production in the FIRST value

If we have any @ terms in FIRST then insert the productions in FOLLOW values

Constructing the predictive parser table

7.4 PROCEDURE:

Go to debug -> run or press CTRL + F9 to run the program.

7.5 PROGRAM:

```
#include<stdio.h>
#include<conio.h>
#include<string.h>
char prol[7][10]={ "S","A","A","B","B","C","C"};
char pror[7][10]={ "A","Bb","Cd","aB","@","Cc","@"};
char prod[7][10]={ "S->A","A->Bb","A->Cd","B->aB","B->@","C->Cc","C-
>@"}; char first[7][10]={ "abcd","ab","cd","a@","@","c@","@"}; char
follow[7][10]={ "$","$","$","a$","b$","c$","d$"};
char table[5][6][10];
numr(char c)
{
switch(c)
{
case 'S': return 0;
case 'A': return 1;
case 'B': return 2;
case 'C': return 3;
case 'a': return 0;
case 'b': return 1;
case 'c': return 2;
case 'd': return 3;
case '$': return 4;
}
return(2);
}
void main()
{
int i,j,k;
clrscr();
for(i=0;i<5;i++)
for(j=0;j<6;j++)
strcpy(table[i][j]," ");
printf("\nThe following is the predictive parsing table for the following
grammar:\n"); for(i=0;i<7;i++)
printf("%s\n",prod[i]);
printf("\nPredictive parsing table is\n");
```

```

fflush(stdin);
for(i=0;i<7;i++)
{
k=strlen(first[i]);
for(j=0;j<10;j++)
if(first[i][j]!='@')
strcpy(table[numr(prol[i][0])+1][numr(first[i][j])+1],prod[i]);
}
for(i=0;i<7;i++)
{
if(strlen(pror[i])==1)
{
if(pror[i][0]=='@')
{
k=strlen(follow[i]);
for(j=0;j<k;j++)
strcpy(table[numr(prol[i][0])+1][numr(follow[i][j])+1],prod[i]);
14}
}
}
strcpy(table[0][0]," ");
strcpy(table[0][1],"a");
strcpy(table[0][2],"b");
strcpy(table[0][3],"c");
strcpy(table[0][4],"d");
strcpy(table[0][5],"$");
strcpy(table[1][0],"S");
strcpy(table[2][0],"A");
strcpy(table[3][0],"B");
strcpy(table[4][0],"C");
printf("\n-----\n");
for(i=0;i<5;i++)
for(j=0;j<6;j++)
{
printf("%-10s",table[i][j]);
if(j==5)
printf("\n-----\n");
}
getch();
}

```

7.6 PRE LAB QUESTIONS:

- 1.What is top-down parsing?
- 2.What are the disadvantages of brute force method?
- 3.What is context free grammar?
- 4.What is parse tree?
5. What is ambiguous grammar?
6. What are the derivation methods to generate a string for the given grammar?
7. What is the output of parse tree?

7.7 LAB ASSIGNMENT:

1. Write a program to compute FIRST for the following grammar?

$E \rightarrow TE'$

$E' \rightarrow +TE' / @$

$T \rightarrow FT'$

$T' \rightarrow *FT' / @$

$F \rightarrow (E) / ID$

2. Write a program to compute FIRST for the following grammar?

$S \rightarrow iCtSS'$

$S' \rightarrow eS / \epsilon$

3. Write a program to construct predictive parsing table for the following grammar?

$S \rightarrow iCtSS'$

$S' \rightarrow eS / \epsilon$

7.8 POST LAB QUESTIONS

1. What is Predictive parser?

2. How many types of analysis can we do using Parser?

3. What is Recursive Decent Parser?

4. How many types of Parsers are there?

5. What is LR Parser?

7.9 INPUT & OUTPUT:

The following is the predictive parsing table for the following grammar:

$S \rightarrow A$

$A \rightarrow Bb$

$A \rightarrow Cd$

$B \rightarrow aB$

$B \rightarrow @$

$C \rightarrow Cc$

$C \rightarrow @$

Predictive parsing table is

a

b

c

d

\$

S

$S \rightarrow AS \rightarrow AS \rightarrow A \quad S \rightarrow A$

A $A \rightarrow Bb \quad A \rightarrow Bb \quad A \rightarrow Cd \quad A \rightarrow Cd$

B

$B \rightarrow aB$

$B \rightarrow @$

$B \rightarrow @$

$B \rightarrow @$

C

$C \rightarrow @C \rightarrow @ \quad C \rightarrow @$

EXPERIMENT-8(a)

8.1

OBJECTIVE:

*Write a C program for constructing of LL (1) parsing.

8.2

RESOURCE:

Turbo C++

8.3

PROGRAM LOGIC:

Read the input string.

Using predictive parsing table parse the given input using stack .

If stack [i] matches with token input string pop the token else shift it repeat the process until it reaches

to \$.

8.4

PROCEDURE:

Go to debug -> run or press CTRL + F9 to run the program.

8.5

PROGRAM

```
#include<stdio.h>
#include<conio.h>
#include<string.h>
char s[20],stack[20];
void main()
{
char m[5][6][3]={ "tb"," ","","tb"," "," "," ","+tb"," "," ","n","n","fc"," "," ","fc"," "," "," "
,"n","*fc"," a ","n","n","i"," "," ","(e)"," "," "};
int size[5][6]={2,0,0,2,0,0,0,3,0,0,1,1,2,0,0,2,0,0,0,1,3,0,1,1,1,0,0,3,0,0};
int i,j,k,n,str1,str2;
clrscr();
printf("\n Enter the input string: ");
scanf("%s",s);
strcat(s,"$");
n=strlen(s);
stack[0]='$';
stack[1]='e';
i=1;
j=0;
printf("\nStack
Input\n");
printf("_____ \n");
while((stack[i]!='$')&&(s[j]!='$'))
{
if(stack[i]==s[j])
{
i--;
j++;
17
}switch(stack[i])
{
```



```

case 'e': str1=0;
break;
case 'b': str1=1;
break;
case 't': str1=2;
break;
case 'c': str1=3;
break;
case 'f': str1=4;
break;
}
switch(s[j])
{
case 'i': str2=0;
break;
case '+': str2=1;
break;
case '*': str2=2;
break;
case '(': str2=3;
break;
case ')': str2=4;
break;
case '$': str2=5;
break;
}
if(m[str1][str2][0]=='\0')
{
printf("\nERROR");
exit(0);
}
else if(m[str1][str2][0]=='n')
i--;
else if(m[str1][str2][0]=='i')
stack[i]='i';
else
{
for(k=size[str1][str2]-1;k>=0;k--)
{
stack[i]=m[str1][str2][k];
i++;
}
i--;
}
for(k=0;k<=i;k++)
printf(" %c",stack[k]);
printf("
");
for(k=j;k<=n;k++)
printf("%c",s[k]);

```

```
printf(" \n ");  
}  
printf("\n SUCCESS");  
getch(); }
```

8.6

INPUT & OUTPUT:

Enter the input string:i*i+i

Stack

INPUT

\$bt i*i+i\$

\$bcf i*i+i\$

\$bci i*i+i\$

\$bc *i+i\$

\$bcf* *i+i\$

\$bcf i+i\$

\$bci i+i\$

\$bc +i\$

\$b +i\$

\$bt+ +i\$

\$bt i\$

\$bcf i\$

\$ bci i\$

\$bc \$

\$b \$

\$ \$

success

EXPERIMENT-8(b)

8.1

OBJECTIVE:

Construction of recursive descent parsing for the following grammar

$E \rightarrow TE'$

$E' \rightarrow +TE'/@$

$T \rightarrow FT'$

$T' \rightarrow *FT'/@$

$F \rightarrow (E)/ID$

"@ represents null character"

8.2

RESOURCE: C++

8.3

PROGRAM LOGIC:

Read the input string.

Write procedures for the non terminals

Verify the next token equals to non terminals if it satisfies match the non terminal.

If the input string does not match print error.

8.4

PROCEDURE:

Go to debug -> run or press CTRL + F9 to run the program.

8.5

PROGRAM:

```
#include<stdio.h>
#include<conio.h>
#include<string.h>
char input[100];
int i,l;
void main()
{
clrscr();
printf("\nRecursive descent parsing for the following grammar\n");
printf("\nE->TE\nE'->+TE'/@\nT->FT\nT'->*FT'/@\nF->(E)/ID\n");
printf("\nEnter the string to be checked:"); gets(input);
if(E())
{
if(input[i+1]=='\0')
printf("\nString is accepted");
else
printf("\nString is not accepted");
}
else
printf("\nString not accepted");
getch();}
E()
{
if(T())
{
if(EP())
return(1);
else
```

```

return(0);
}
else
return(0);
}
EP()
{
if(input[i]=='+')
{
i++;
if(T())
{
if(EP())
return(1);
else
return(0);
}
else
return(0);
}
else
return(1);
}
T()
{
if(F())
{
if(TP())
return(1);
else
return(0);
}
else
return(0);
}
TP()
{
if(input[i]=='*')
{
i++;
if(F())
{
if(TP())
return(1);
else
return(0);
}
else
return(0);
}
}

```

```

else
return(1);
}
F()
{
if(input[i]=='(')
{
i++;
if(E())
{
if(input[i]==')')
{
i++;
return(1);
}
}
else
return(0);
}
else
return(0);
}
else if(input[i]>='a'&&input[i]<='z'||input[i]>='A'&&input[i]<='Z')
{
i++;
return(1);
}
else
return(0);
}

```

8.6

INPUT & OUTPUT:

Recursive descent parsing for the following grammar

$E \rightarrow TE'$

$E' \rightarrow +TE' / @$

$T \rightarrow FT'$

$T' \rightarrow *FT' / @$

$F \rightarrow (E) / ID$

Enter the string to be checked: $(a+b)*c$

String is accepted

Recursive descent parsing for the following grammar

$E \rightarrow TE'$

$E' \rightarrow +TE' / @$

$T \rightarrow FT'$

$T' \rightarrow *FT' / @$

$F \rightarrow (E) / ID$

Enter the string to be checked: $a/c+d$

String is not accepted

EXPERIMENT-9

9.1

OBJECTIVE:

Write a program to Design LALR Bottom up Parser.

9.2

RESOURCE: C++

9.3

PROGRAM LOGIC:

Read the input string.

Push the input symbol with its state symbols in to the stack by referring lookaheads

We perform shift and reduce actions to parse the grammar.

Parsing is completed when we reach \$ symbol.

9.4

PROCEDURE:

Go to debug -> run or press CTRL + F9 to run the program.

9.5

PROGRAM:

```
/*LALR PARSER
E->E+T
E->T
T->T*F
T->F
F->(E)
F->ε
*/
#include<stdio.h>
#include<conio.h>
#include<stdlib.h>
#include<string.h>
void push(char *,int *,char);
char stacktop(char *);
void isproduct(char,char);
int ister(char);
int isnter(char);
int isstate(char);
void error();
void isreduce(char,char);
char pop(char *,int *);
void printt(char *,int *,char [],int);
void rep(char [],int);
struct action
{
char row[6][5];
};
const struct action A[12]={
{"sf","emp","emp","se","emp","emp"},
{"emp","sg","emp","emp","emp","acc"},
{"emp","rc","sh","emp","rc","rc"},
{"emp","re","re","emp","re","re"},
{"sf","emp","emp","se","emp","emp"},
```

```

{"emp","rg","rg","emp","rg","rg"},
{"sf","emp","emp","se","emp","emp"},
{"sf","emp","emp","se","emp","emp"},
{"emp","sg","emp","emp","sl","emp"},
{"emp","rb","sh","emp","rb","rb"},
{"emp","rb","rd","emp","rd","rd"},
{"emp","rf","rf","emp","rf","rf"}
};
struct gotol
{
char r[3][4];
};
const struct gotol G[12]={
{"b","c","d"},
{"emp","emp","emp"},
{"emp","emp","emp"},
{"emp","emp","emp"},
{"i","c","d"},
{"emp","emp","emp"},
{"emp","j","d"},
{"emp","emp","k"},
{"emp","emp","emp"},
{"emp","emp","emp"},
};
char ter[6]={ 'i','+','*','(',')','('$')};
char nter[3]={ 'E','T','F'};
char states[12]={ 'a','b','c','d','e','f','g','h','m','j','k','l'};
char stack[100];
int top=-1;
char temp[10];
struct grammar
{
char left;
char right[5];
};
const struct grammar rl[6]={
{'E',"e+T"},
{'E',"T"},
{'T',"T*F"},
{'T',"F"},
{'F'," (E)"},
{'F',"i"},
};
void main()
{
char inp[80],x,p,dl[80],y,bl='a';
int i=0,j,k,l,n,m,c,len;
clrscr();
printf(" Enter the input :");
scanf("%s",inp);

```

```

len=strlen(inp);
inp[len]='$';
inp[len+1]='\0';
push(stack,&top,bl);
printf("\n stack \t\t\t input");
printt(stack,&top,inp,i);
doi++;
}
else
{
if(temp[0]=='r')
{
j=isstate(temp[1]);
strcpy(temp,rl[j-2].right);
dl[0]=rl[j-2].left;
dl[1]='\0';
n=strlen(temp);
for(k=0;k<2*n;k++)
pop(stack,&top);
for(m=0;dl[m]!='\0';m++)
push(stack,&top,dl[m]);
l=top;
y=stack[l-1];
isreduce(y,dl[0]);
for(m=0;temp[m]!='\0';m++)
push(stack,&top,temp[m]);
}
}
}
printt(stack,&top,inp,i);
}while(inp[i]!='\0');
if(strcmp(temp,"acc")==0)
printf(" \n accept the input ");
else
printf(" \n do not accept the input ");
getch();
}
void push(char *s,int *sp,char item)
{
if(*sp==100)
printf(" stack is full ");
else
{
*sp=*sp+1;
s[*sp]=item;
}
}
char stacktop(char *s)
{
char i;

```



```

i=s[top];
return i;
}
void isproduct(char x,char p)
{
int k,l;
k=ister(x);
l=isstate(p);
strcpy(temp,A[l-1].row[k-1]);
}
int ister(char x)
{
int i;
for(i=0;i<6;i++)
if(x==ter[i])
return i+1;
return 0;
}
int isnter(char x)
{
int i;
for(i=0;i<3;i++)
if(x==nter[i])
return i+1;
return 0;
}
int isstate(char p)
{
int i;
for(i=0;i<12;i++)
if(p==states[i])
return i+1;
return 0;
}
void error()
{
printf(" error in the input ");
exit(0);
}
void isreduce(char x,char p)
{
int k,l;
k=isstate(x);
l=isnter(p);
strcpy(temp,G[k-1].r[l-1]);
}
char pop(char *s,int *sp)
{
char item;
if(*sp== -1)

```

```

printf(" stack is empty ");
else
{
item=s[*sp];
*sp=*sp-1;
}
return item;
}
void printt(char *t,int *p,char inp[],int i)
{
int r;
printf("\n");
for(r=0;r<=*p;r++)
rep(t,r);
printf("\t\t\t");
for(r=i;inp[r]!='\0';r++)
printf("%c",inp[r]);}
void rep(char t[],int r)
{
char c;
c=t[r];
switch(c)
{
case 'a': printf("0");
break;
case 'b': printf("1");
break;
case 'c': printf("2");
break;
case 'd': printf("3");
break;
case 'e': printf("4");
break;
case 'f': printf("5");
break;
case 'g': printf("6");
break;
case 'h': printf("7");
break;
case 'm': printf("8");
break;
case 'j': printf("9");
break;
case 'k': printf("10");
break;
case 'l': printf("11");
break;
default :printf("%c",t[r]);
break;
}
}

```

}

9.6

PRE-LAB QUESTIONS

1. Why bottom-up parsing is also called as shift reduce parsing?
2. What are the different types of bottom up parsers?
3. What is mean by LR (0) items?
4. Write the general form of LR(1) item?
5. What is YACC?

9.7

LAB ASSIGNMENT

1. Write a program to compute FOLLOW for the following grammar?

$$\begin{aligned} E &\rightarrow TE' \\ E' &\rightarrow +TE'/\epsilon \\ T &\rightarrow FT' \\ T' &\rightarrow *FT'/\epsilon \\ F &\rightarrow (E)/\epsilon \end{aligned}$$

2

- Write a program to construct LALR parsing table for the following grammar.

$$\begin{aligned} S &\rightarrow iCtSS' \\ S' &\rightarrow eS/\epsilon \end{aligned}$$

9.8

POST-LAB QUESTIONS:

1. What is LALR parsing?
2. What is Shift reduced parser?
3. What are the operations of Parser?
4. What is the use of parsing table?
5. What is bottom up parsing?

9.9

INPUT & OUTPUT:

Enter the input: $i*i+1$

Output

Stack input

0 $i*i+i\$$

0i5 $*i+i\$$

0F3 $*i+i\$$

0T2 $*i+i\$$

0T2*7 $i+i\$$

0T2*7i5 $+i\$$

0T2*7i5F10 $+i\$$

0T2 $+i\$$

0E1 $+i\$$

0E1+6 $i\$$

0E1+6i5 $\$$

0E1+6F3 $\$$

0E1+6T9 $\$$

0E1 $\$$

accept the input*/

EXPERIMENT-10(a)

10.1 **OBJECTIVE**:*Write a C program to implement operator precedence parsing.

10.2 **RESOURCE**:

Turbo C++

10.3 **PROGRAM LOGIC**:

Read the arithmetic input string.

Verify the precedence between terminals and symbols

Find the handle enclosed in < . > and reduce it to production symbol.

Repeat the process till we reach the start node.

10.4 **PROCEDURE**:

Go to debug -> run or press CTRL + F9 to run the program.

10.5 **PROGRAM**:

```
#include<stdio.h>
char str[50],opstr[75];
int f[2][9]={2,3,4,4,4,0,6,6,0,1,1,3,3,5,5,0,5,0};
int col,col1,col2;
char c;
swt()
{
switch(c)
{
case'+':col=0;break;
case'-':col=1;break;
case'*':col=2;break;
case'/':col=3;break;
case'^':col=4;break;
case'(':col=5;break;
case')':col=6;break;
case'd':col=7;break;
case'$':col=8;break;
default:printf("\nTERMINAL MISSMATCH\n");
exit(1);
break;
}
// return 0;
}
main()
{
int i=0,j=0,col1,cn,k=0;
int t1=0,foundg=0;
char temp[20];
clrscr();
printf("\nEnter arithmetic expression:");
scanf("%s",&str);
while(str[i]!='\0')
i++;
str[i]='$';
str[++i]='\0';
printf("%s\n",str);
come:
```

```

i=0;
opstr[0]='$';
j=1;
c='$';
swt();
col1=col;
c=str[i];
swt();
col2=col;
if(f[1][col1]>f[2][col2])
{
opstr[j]='>';
j++;
}
else if(f[1][col1]<f[2][col2])
{
opstr[j]='<';
j++;
}
else{
opstr[j]='=';j++;
}
while(str[i]!='$')
{
c=str[i];
swt();
col1=col;
c=str[++i];
swt();
col2=col;
opstr[j]=str[--i];
j++;
if(f[0][col1]>f[1][col2])
{
opstr[j]='>';
j++;
}
else if(f[0][col1]<f[1][col2])
{
opstr[j]='<';
j++;
}
else
{
opstr[j]='=';j++;
}
i++;
}
opstr[j]='$';
opstr[++j]='\0';

```

```

printf("\nPrecedence Input:%s\n",opstr);
i=0;
j=0;
while(opstr[i]!='\0')
{
foundg=0;while(foundg!=1)
{
if(opstr[i]=='\0')goto redone;
if(opstr[i]=='>')foundg=1;
t1=i;
i++;
}
if(foundg==1)
for(i=t1;i>0;i--)
if(opstr[i]=='<')break;
if(i==0){printf("\nERROR\n");exit(1);}
cn=i;
j=0;
i=t1+1;
while(opstr[i]!='\0')
{
temp[j]=opstr[i];
j++;i++;
}
temp[j]='\0';
opstr[cn]='E';
opstr[++cn]='\0';
strcat(opstr,temp);
printf("\n%s",opstr);
i=1;
}
redone:k=0;
while(opstr[k]!='\0')
{
k++;
if(opstr[k]=='<')
{
Printf("\nError");
exit(1);
}
}
if((opstr[0]=='$')&&(opstr[2]=='$'))goto sue;
i=1while(opstr[i]!='\0')
{
c=opstr[i];
if(c=='+'||c=='*'||c=='/'||c=='$')
{
temp[j]=c;j++;}
i++;
}

```

```
temp[j]='\0';
strcpy(str,temp);
goto come;
sue:
printf("\n success");
return 0;
}
```

10.6 INPUT & OUTPUT:

Enter the arithmetic expression

(d*d)+d\$

Output:

(d*d)+d\$

Precedence input:\$<(<d>*<d>)>+<d>\$

\$<(E*<d>)>+<d>\$

\$<(E*E)>+<E>\$

\$E+<E>\$

\$E+E\$

Precedence input:\$<+>\$

\$E\$

success

EXPERIMENT-10(b)

10.1 OBJECTIVE:

Program to implement semantic rules to calculate the expression that takes an expression with digits, + and * and computes the value.

10.2 RESOURCE:Linux using putty

10.3 PROCEDURE:

Reading an input file

Calculate the sum or multiplication of given expression.

Using expression rule print the result of the given values.

10.4 PROGRAM:

```
<parser.l>
% {
#include<stdio.h>
#include "y.tab.h"
% }
%%
[0-9]+ { yylval.dval=atof(yytext);
return DIGIT;
}
\n|. return yytext[0];
%%
<parser.y>
% {
/*This YACC specification file generates the LALR parser for the program
considered in experiment 4.*/
#include<stdio.h>
% }
% union
{
double dval;
}
%token <dval> DIGIT
%type <dval> expr
%type <dval> term
%type <dval> factor
%%
line: expr '\n' {
printf("%g\n", $1);
}
;
expr: expr '+' term { $$=$1 + $3 ;}
| term
;term: term '*' factor { $$=$1 * $3 ;}
| factor
;
factor: '(' expr ')' { $$=$2 ;}
| DIGIT
;
%%
int main()
```



```
{  
yyparse();  
}  
yyerror(char *s)  
{  
printf("%s",s);  
}
```

10.6 INPUT & OUTPUT:

```
$lex parser.l  
$yacc -d parser.y  
$cc lex.yy.c y.tab.c -ll -lm  
$./a.out  
2+3  
5.0000
```

EXPERIMENT-11

11.1 OBJECTIVE:

Convert The BNF rules into Yacc form and write code to generate abstract syntax tree.

11.2 RESOURCE : linux using putty

11.3 PROGRAM LOGIC:Reading an input file line by line.

Convert it in to abstract syntax tree using three address code.

Represent three address code in the form of quadruple tabular form.

11.4 PROCEDURE:

Go to terminal .Open vi editor ,Lex lex.l , cc lex.yy.c , ./a.out

11.5 PROGRAM

```
<int.l>
%{
#include"y.tab.h"
#include<stdio.h>
#include<string.h>
int LineNo=1;
%}
identifier [a-zA-Z][_a-zA-Z0-9]*
number [0-9]+|([0-9]*\.[0-9]+)
%%
main\(\) return MAIN;
if return IF;
else return ELSE;
while return WHILE;
int |
char |
float return TYPE;
{identifier} {strcpy(yylval.var,yytext);
return VAR;}
{number} {strcpy(yylval.var,yytext);
return NUM;}
□ |> |>= |<= |== {strcpy(yylval.var,yytext);
return RELOP;}
[ \t] ;
\n LineNo++;
. return yytext[0];
%%
<int.y> %
{ #include<string.h>
>
#include<stdio.h>
struct quad{
char op[5]; char
arg1[10]; char
arg2[10]; char
result[10];
}QUAD[30];
struct stack{
int items[100];
int top;
```

```

}stk;
int Index=0,tIndex=0,StNo,Ind,tInd;
extern int LineNo;
% }
%union{
char var[10];
}
%token <var> NUM VAR RELOP
%token MAIN IF ELSE WHILE TYPE
%type <var> EXPR ASSIGNMENT CONDITION IFST ELSEST WHILELOOP
%left '-' '+'
%left '*' '/'
%%PROGRAM : MAIN BLOCK
;
BLOCK: '{' CODE '}'
;
CODE: BLOCK
| STATEMENT CODE
| STATEMENT
;
STATEMENT: DESCT ';'
| ASSIGNMENT ';'
| CONDST
| WHILEST
;
DESCT: TYPE VARLIST
;
VARLIST: VAR ',' VARLIST
| VAR
;
ASSIGNMENT: VAR '=' EXPR{
strcpy(QUAD[Index].op,"=");
strcpy(QUAD[Index].arg1,$3);
strcpy(QUAD[Index].arg2,"");
strcpy(QUAD[Index].result,$1);
strcpy($$,QUAD[Index++].result);
}
;
EXPR: EXPR '+' EXPR {AddQuadruple("+",$1,$3,$$);}
| EXPR '-' EXPR {AddQuadruple("-", $1,$3,$$);}
| EXPR '*' EXPR {AddQuadruple("*",$1,$3,$$);}
| EXPR '/' EXPR {AddQuadruple("/", $1,$3,$$);}
| '-' EXPR {AddQuadruple("UMIN",$2,"",$$);}
| '(' EXPR ')' {strcpy($$, $2);}
| VAR
| NUM
;
CONDST: IFST{
Ind=pop();
sprintf(QUAD[Ind].result,"%d",Index);

```

```

Ind=pop();
sprintf(QUAD[Index].result,"%d",Index);
}
| IFST ELSEST
;
IFST: IF '(' CONDITION ')' {
strcpy(QUAD[Index].op,"==");
strcpy(QUAD[Index].arg1,$3);
strcpy(QUAD[Index].arg2,"FALSE");
strcpy(QUAD[Index].result,"-1");
push(Index);
Index++;
}
BLOCK {
strcpy(QUAD[Index].op,"GOTO");
strcpy(QUAD[Index].arg1,"");
strcpy(QUAD[Index].arg2,"");
strcpy(QUAD[Index].result,"-1");
push(Index);
Index++;
};
ELSEST: ELSE{
tInd=pop();
Ind=pop();push(tInd);
sprintf(QUAD[Index].result,"%d",Index);
}
BLOCK{
Ind=pop();
sprintf(QUAD[Index].result,"%d",Index);
};
CONDITION: VAR RELOP VAR { AddQuadruple($2,$1,$3,$$);
StNo=Index-1;
}
| VAR
| NUM
;
WHILEST: WHILELOOP{
Ind=pop();
sprintf(QUAD[Index].result,"%d",StNo);
Ind=pop();
sprintf(QUAD[Index].result,"%d",Index);
}
;
WHILELOOP: WHILE '(' CONDITION ')' {
strcpy(QUAD[Index].op,"==");
strcpy(QUAD[Index].arg1,$3);
strcpy(QUAD[Index].arg2,"FALSE");
strcpy(QUAD[Index].result,"-1");
push(Index);
Index++;

```

```

}
BLOCK {
strcpy(QUAD[Index].op,"GOTO");
strcpy(QUAD[Index].arg1,"");
strcpy(QUAD[Index].arg2,"");
strcpy(QUAD[Index].result,"-1");
push(Index);
Index++;
}
;
%%
extern FILE *yyin;
int main(int argc,char *argv[]) {
FILE *fp;
int i;
if(argc>1){
fp=fopen(argv[1],"r");
if(!fp) {
printf("\n File not found");
exit(0);
}
yyin=fp;
}
yyparse();
printf("\n\n\t\t -----""\n\t\t Pos Operator Arg1 Arg2 Result" "\n\t\t
-----");
for(i=0;i<Index;i++)
{
printf("\n\t\t %d\t %s\t %s\t %s\t
%s",i,QUAD[i].op,QUAD[i].arg1,QUAD[i].arg2,QUAD[i].result);
}
printf("\n\t\t -----");
printf("\n\n");
return 0;
} void push(int data){
stk.top++;
if(stk.top==100)
{
printf("\n Stack overflow\n");
exit(0);
}
stk.items[stk.top]=data;
}
int pop()
{
int data;
if(stk.top== -1){
printf("\n Stack underflow\n");
exit(0);}
data=stk.items[stk.top--];

```

```

return data;
}
void AddQuadruple(char op[5],char arg1[10],char arg2[10],char result[10])
{
strcpy(QUAD[Index].op,op);
strcpy(QUAD[Index].arg1,arg1);
strcpy(QUAD[Index].arg2,arg2);
sprintf(QUAD[Index].result,"t%d",tIndex++);
strcpy(result,QUAD[Index++].result);
}
yyerror()
{
printf("\n Error on line no:%d",LineNo);
}
Input:
$vi test.c
main()
{
int a,b,c;
if(a<b)
{
a=a+b;
}
while(a<b){
a=a+b;
}
if(a<=b){
c=a-b;
}
else
{
c=a+b;
}
}

```

11.7 PRE-LAB QUESTIONS

1. What are the functions we use to construct a syntax tree?
2. What is Meta data?
3. How list of identifiers are represented using BNF rules?
4. What is three address code?
5. What are the record structures we use to represent three address code?

11.8

LAB ASSIGNMENT

1

Write YACC for the desktop calculator?

Write BNF rules for the following grammar?

$E \rightarrow TE'$

$E' \rightarrow +TE'/\epsilon$

$T \rightarrow FT'$

$T' \rightarrow *FT'/\epsilon$

$F \rightarrow (E)/Id$

11.

POST-LAB QUESTIONS:

1. What is Abstract Syntax tree?
2. What are BNF Rules?
3. What is DAG representation?
4. How LALR (1) states are generated?
5. In which condition the user has to supply more information to YACC?

11.10 INPUT & OUTPUT:

```
$lex int.l  
$yacc -d int.y  
$gcc lex.yy.c y.tab.c -ll -lm$./a.out test.c
```

OUTPUT

Pos

0 Operator

< Arg1

a 1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16 ==

+

==

GOTO

<

==

+

=

GOTO

<=

==

-

=

GOTO

+

= t0

a

t1 FALSE
b 5
t1
5
a
t2
a
t3 b
FALSE
b a
t4
a
t5 b
FALSE
b a
t6 b t2
10
t3
a
5
t4
t5
c
t6
c
Arg2
b
Result
t0

EXPERIMENT-12

12.1 OBJECTIVE:

Write a C program to generate machine code from abstract syntax tree generated by the parser. The instruction set specified in Note 2 may be considered as the target code.

12.2 RESOURCE:

TURBO C++

12.3

PROGRAM LOGIC:

Read input string Consider each input string and convert in to machine code instructions

12.4 PROCEDURE:

Go to terminal .Open vi editor ,Lex lex.l , cc lex.yy.c ,

./a.out

12.5 PROGRAM:

```
#include<stdio.h>
#include<stdlib.h>
#include<string.h>
int label[20];
int no=0;
int main()
{
FILE *fp1,*fp2;
char fname[10],op[10],ch;
char operand1[8],operand2[8],result[8];
int i=0,j=0;
printf("\n Enter filename of the intermediate code");
scanf("%s",&fname);
fp1=fopen(fname,"r");
fp2=fopen("target.txt","w");
if(fp1==NULL || fp2==NULL)
{
printf("\n Error opening the file");
exit(0);
}
while(!feof(fp1))
{
fprintf(fp2,"\n"); fscanf(fp1,"%s",op);
i++; if(check_label(i))
fprintf(fp2,"\nlabel#%d",i);
if(strcmp(op,"print")==0)
{
fscanf(fp1,"%s",result);
fprintf(fp2,"\n\t OUT %s",result);
}
if(strcmp(op,"goto")==0)
{
fscanf(fp1,"%s %s",operand1,operand2);
fprintf(fp2,"\n\t JMP %s,label#%s",operand1,operand2);
label[no++]=atoi(operand2);
}
if(strcmp(op,"[]")==0)
{

```

```

fscanf(fp1,"%s %s %s",operand1,operand2,result);
fprintf(fp2,"\n\t STORE %s[%s],%s",operand1,operand2,result);
}
if(strcmp(op,"uminus")==0)
{
fscanf(fp1,"%s %s",operand1,result);
fprintf(fp2,"\n\t LOAD -%s,R1",operand1);
fprintf(fp2,"\n\t STORE R1,%s",result);
}
switch(op[0])
{
case '*':
fscanf(fp1,"%s %s %s",operand1,operand2,result);
fprintf(fp2,"\n\t
LOAD",operand1);
fprintf(fp2,"\n\t LOAD
%s,R1",operand2);
fprintf(fp2,"\n\t MUL R1,R0");
fprintf(fp2,"\n\t STORE
R0,%s",result); break;
case '+': fscanf(fp1,"%s %s
%s",operand1,operand2,result);
fprintf(fp2,"\n\t LOAD %s,R0",operand1);
fprintf(fp2,"\n\t LOAD %s,R1",operand2);
fprintf(fp2,"\n\t ADD R1,R0");
fprintf(fp2,"\n\t STORE R0,%s",result);
break;
case '-': fscanf(fp1,"%s %s
%s",operand1,operand2,result); fprintf(fp2,"\n
\t LOAD %s,R0",operand1); fprintf(fp2,"\n\t
LOAD %s,R1",operand2); fprintf(fp2,"\n\t
SUB R1,R0");fprintf(fp2,"\n\t STORE R0,%s",result);
break;
case '/':
fscanf(fp1,"%s %s %s",operand1,operand2,result);
fprintf(fp2,"\n\t LOAD %s,R0",operand1);
fprintf(fp2,"\n\t LOAD %s,R1",operand2);
fprintf(fp2,"\n\t DIV R1,R0");
fprintf(fp2,"\n\t STORE R0,%s",result);
break;
case '%':
fscanf(fp1,"%s %s %s %s",operand1,operand2,result);
fprintf(fp2,"\n\t LOAD %s,R0",operand1);
fprintf(fp2,"\n\t LOAD %s,R1",operand2);
fprintf(fp2,"\n\t DIV R1,R0");
fprintf(fp2,"\n\t STORE R0,%s",result);
break;
case '=':
fscanf(fp1,"%s %s",operand1,result);
fprintf(fp2,"\n\t STORE %s %s",operand1,result);

```

```

break;
case '>': j++;
fscanf(fp1,"%s %s %s",operand1,operand2,result);
fprintf(fp2,"\n \t LOAD %s,R0",operand1);
fprintf(fp2,"\n \t JGT %s,label#%s",operand2,result);
label[no++]=atoi(result);
break;
case '<': fscanf(fp1,"%s %s %s",operand1,operand2,result);
fprintf(fp2,"\n \t LOAD %s,R0",operand1);
fprintf(fp2,"\n \t JLT %s,label#%d",operand2,result);
label[no++]=atoi(result);
break;
}
}
fclose(fp2); fclose(fp1);
fp2=fopen("target.txt","r");
if(fp2==NULL)
{
printf("Error opening the file\n");
exit(0);
}
do
{
ch=fgetc(fp2);
printf("%c",ch);
}while(ch!=EOF);
fclose(fp1);
return 0;
}
int check_label(int k)
{int i;
for(i=0;i<no;i++)
{
if(k==label[i])
return 1;
}
return 0;
}

```

12.6 PRE-LAB QUESTIONS

1. What are the different forms of object code?
2. What is meant by relocatable object code?
3. What is the cost of register to register operation?
4. What is address descriptor?
5. What is register descriptor?

12.7 LAB ASSIGNMENT

1 Write a program to generate the code for the following three address code statements? $A=B+C$

$W=X-Y$

2 Write a program to generate the code for the following three address code

statements? $W=(A+B)*C$

12.8 POST-LAB QUESTIONS

12.9

1. What is target code?
2. What is machine code?
3. What is Cross compiler?
4. Give the example for cross compiler?
5. What is the difference between syntax & Semantics?

INPUT & OUTPUT:

\$vi int.txt

=t1 2

[]=a 0 1

[]=a 1 2

[]=a 2 3

*t1 6 t2

+a[2] t2 t3

-a[2] t1 t2

/t3 t2 t2

uminus t2 t2

print t2

goto t2 t3

=t3 99

uminus 25 t2

*t2 t3 t3

uminus t1 t1

+t1 t3 t4

print t4

47

Output:

Enter filename of the intermediate code: int.txt

STORE t1,2

STORE a[0],1

STORE a[1],2STORE a[2],3

LOAD t1,R0

LOAD 6,R1

ADD R1,R0

STORE R0,t3

LOAD a[2],R0

LOAD t2,R1

ADD R1,R0

STORE R0,t3

LOAD a[t2],R0

LOAD t1,R1

SUB R1,R0

STORE R0,t2

LOAD t3,R0

LOAD t2,R1

```
DIV R1,R0
STORE R0,t2
LOAD t2,R1
STORE R1,t2
LOAD t2,R0
JGT 5,label#11
Label#11: OUT t2
JMP t2,label#13
Label#13: STORE t3,99
LOAD 25,R1
STORE R1,t2
LOAD t2,R0
LOAD t3,R1
MUL R1,R0
STORE R0,t3
LOAD t1,R1
STORE R1,t1
LOAD t1,R0
LOAD t3,R1
ADD R1,R0
STORE R0,t4
OUT t4
```