

M.V.S.R. ENGINEERING COLLEGE

(Affiliated to Osmania University & Recognized by AICTE)

Nadergul, RangaReddy Dist.



CERTIFICATE

Department of **COMPUTER SCIENCE & ENGINEERING**

Certified that this is a bonafide work of lab experiments carried out by Mr/Ms. _____ bearing Roll.No. _____ under the course of **Compiler Construction** Laboratory prescribed by Osmania University for **B.E. Sem-VII** of Computer Science & Engineering during the academic year 2019–2020.

Internal Examiner

External Examiner

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

VISION

- To impart technical education of the highest standards, producing competent and confident engineers with an ability to use computer science knowledge to solve societal problems.

MISSION

- To make learning process exciting, stimulating and interesting.
- To impart adequate fundamental knowledge and soft skills to students.
- To expose students to advanced computer technologies in order to excel in engineering practices by bringing out the creativity in students.
- To develop economically feasible and socially acceptable software.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

The Program Educational Objectives of undergraduate program in Computer Science & Engineering are to prepare graduates who will:

1. Obtain strong fundamentals concepts, technical competency and problem solving skills to generate innovative solutions to engineering problems.
2. Continuously enhance their skills through training, independent inquiry, professional practices and pursue higher education or research by adapting to rapidly changing technology.
3. Advance in their professional careers including increased technical, multidisciplinary approach and managerial responsibility as well as attainment of leadership positions thus making them competent professionals at global level.
4. Exhibit commitment to ethical practices, societal contributions and lifelong learning.

(A) PROGRAM OUTCOMES(POs)

At the end of the program the students (Engineering Graduates) will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **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.
4. **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.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **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.
7. **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.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **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.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principle and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Lifelong 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.

(B) PROGRAM SPECIFIC OUTCOMES (PSOs)

13. **Efficient coding:** an ability to analyse a problem, design the algorithm and optimally code its solution.
14. **Software deployment:** an ability to identify & define computing requirements to test, implement and maintain a software product.

| Course Code | Course Title | | | | Core / Elective | | |
|------------------|----------------------------------|---|---|----------|-----------------|-----------|----------|
| PC 751 CS | Compiler Construction Lab | | | | Core | | |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | - | - | - | 2 | 25 | 50 | 1 |

Course Objectives

- To learn usage of tools LEX, YAAC
- To develop a code generator
- To implement different code optimization schemes

Course Outcomes

After completing this course, the student will be able to

1. To Generate scanner and parser from formal specification
2. To design a compiler for a subset of any High level language

M.V.S.R. ENGINEERING COLLEGE

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Nadergul(P.O.), Hyderabad-501510

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

Subject : **Compiler Construction Lab- PC 751 CS** Acad. Year : **2019-20**

Class : **BE IV/IV** Sem – **VII (CBCS)** Section :

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1. TOKENIZING AN ASSIGNMENT STATEMENT

```
#include<stdio.h>
#include<string.h>
void main()
{
    char a[10];
    int x,i;

    printf("enter exp\n");
    gets(a);

    for(i=0;a[i]!='\0';i++)
    {
        if((a[i]>='A' && a[i]<='Z') || (a[i]>='a' && a[i]<='z'))
            printf("\n %c is variable",a[i]);
        else if(a[i]=='=')
            printf("\n %c is assignment operator ",a[i]);

        else if( a[i]=='+' || a[i]=='-' || a[i]=='*' || a[i]=='/' )
            printf("\n %c is arithmetic operator ",a[i]);

        else if(a[i]>='0' && a[i]<='9')
            printf("\n %c is integer ",a[i]);
        else
            printf("\n %c is other character",a[i]);

    }
}
```

Output:

```
./a.out
enter exp
a=b+3;
```

```
a is variable
= is assignment operator
b is variable
+ is arithmetic operator
3 is integer
; is other character
```

2. SAMPLE PROGRAMS USING LEX

a. Identification of a decimal number

```
//decimal.l
% {
#include<stdio.h>
% }
%%
[ \n\t];

[+-]?([0-9]+|([0-9]*\.[0-9]+)([eE][+-]?[0-9]+)?) { printf("number\n");}
. { printf("not a number\n");}
%%
main()
{
  yylex();
}
```

Output:

```
$ lex decimal.l
$ cc lex.yy.c -ll
$ ./a.out
7822.56
number e
```

```
not a number
15.50e4
```

```
number 6
```

```
number
```

b. Word count without using files

```
//wordcount.l
%{
#include<stdio.h>
int wc=0,lc=0,cc=0;
%}
word [^\n\t]+
eol \n
%%
{word} {wc++;cc+=yyleng;}
{eol} {lc++;cc++;}
. {cc++;}
%%
main()
{
yylex();
printf("no. of characters:%d\nno. of words:%d\nno. of lines:%d\n",cc,wc,lc);
}
```

Output:

```
$ lex wordcount.l
$ cc lex.yy.c -ll
$ ./a.out
This is our CC lab.^d
no. of characters:20 no.
of words:5
no. of lines:1
```

c. Word count using files

```
//wordfile.l
%{
#include<stdio.h>
int wc=0,lc=0,cc=0;
%}
word [^\n\t]+
eol \n
%%
{ word} {wc++;cc+=yyleng;}
{eol} {lc++;cc++;}
. {cc++;}
%%
main(int argc,char**argv)
{
if(argc>1)
{
FILE*file;
file=fopen(argv[1],"r");
if(!file)
{
fprintf(stderr,"could not open%s\n",argv[1]);
exit(1);
}
yyin=file;
}
yylex();
printf("no. of characters:%d\nno. of lines:%d\nno.of words:%d\n",cc,lc,wc);
return 0;
}
```

INPUT:

```
//file
This is CC lab.
This is CSE Department. ^d
```

OUTPUT:

```
$ lex wordfile.l
$ cc lex.yy.c -ll
$ ./a.out file no. of
characters:40 no. of lines:2
no.of words:8
```


3. SCANNER PROGRAM USING LEX

```
//scanner.l
//C SCANNER USING LEX
%{
#include<stdio.h>
int lineno=1;
%}
letter [a-zA-z]
digit [0-9]
id {letter}({letter}|{digit})*
num {digit}+
kw "int"|"char"|"float"|"printf"|"main"|"if"|"elseif"|"then"|"void"
rop ">"|"<="|">="|"<"
aop "+"|"-"|"*"|"/"
arr ({id} "{" {num} "}")
pre "#include"|"#define"
par "["|"]"|"("|")"|"{"|"}"
com ("/*"({id}|\n)*"*/")
ws [.,;"]
%%
[\n] {lineno++;}
{ws} {printf("\nspecial symbols =%s \t\tlineno=%d",yytext,lineno);}
{rop} {printf("\nrelational operator=%s \t\tlineno=%d",yytext,lineno);}
"=" {printf("\nassignment operator =%s \t\tlineno=%d",yytext,lineno);}
{aop} {printf("\narithmetic operator= %s \t\tlineno=%d",yytext,lineno);}
{par} {printf("\nparenthesis= %s \t\tlineno=%d",yytext,lineno);}
{pre} {printf("\npreprocessor=%s \t\tlineno=%d",yytext,lineno);}
{kw} {printf("\nkeyword=%s \t\tlineno=%d",yytext,lineno);}
{arr} {printf("\narrays=%s \t\tlineno=%d",yytext,lineno);}
{id} {printf("\nidentifier=%s \t\tlineno=%d",yytext,lineno);}
{num} {printf("\nnumber=%s \t\tlineno=%d",yytext,lineno);}
\[^\n]*\ {printf("\n control string=%s \t\tlineno=%d",yytext,lineno);}
%%
int main(int argc,char* argv[])
{
if(argc>1)
yyin=fopen(argv[1],"r");
else
yyin=stdin;
yylex();
}
```

Output:

```
$ lex lexscanner.l
```

```
$ cc lex.yy.c -ll
```

```
$ ./a.out test.c
```

```
//test.c
```

```
#include<stdio.h>
```

```
void main()
```

```
{
```

```
int a=20,b=10;
```

```
if(a>b)
```

```
printf("%d is greater",a);
```

```
else
```

```
printf("b is greater");
```

```
}
```

```
preprocessor=#include
```

```
lineno=1
```

```
relational operator=<
```

```
lineno=1
```

```
identifier=stdio
```

```
lineno=1
```

```
special symbols =,
```

```
lineno=1
```

```
identifier=h
```

```
lineno=1
```

```
relational operator=>
```

```
lineno=1
```

```
keyword=void
```

```
lineno=2
```

```
keyword=main
```

```
lineno=2
```

```
parenthesis=(
```

```
lineno=2
```

```
parenthesis=)
```

```
lineno=2
```

```
parenthesis={
```

```
lineno=3
```

```
keyword=int
```

```
lineno=4
```

```
identifier=a
```

```
lineno=4
```

```
assignment operator ==
```

```
lineno=4
```

```
number=20
```

```
lineno=4
```

```
special symbols =,
```

```
lineno=4
```

```
identifier=b
```

```
lineno=4
```

```
assignment operator ==
```

```
lineno=4
```

```
number=10
```

```
lineno=4
```

```
special symbols =;
```

```
lineno=4
```

```
keyword=if
```

```
lineno=5
```

```
parenthesis=(
```

```
lineno=5
```

```
identifier=a
```

```
lineno=5
```

```
relational operator=>
```

```
lineno=5
```

```
identifier=b
```

```
lineno=5
```

```
parenthesis=)
```

```
lineno=5
```

```
keyword=printf
```

```
lineno=6
```

```
parenthesis=(
```

```
lineno=6
```

```
control string="%d is greater"
```

```
lineno=6
```

```
special symbols =,
```

```
lineno=6
```

```
identifier=a
```

```
lineno=6
```

```
parenthesis=)
```

```
lineno=6
```

```
special symbols =;
```

```
lineno=6
```

```
identifier=else
```

```
lineno=7
```

```
keyword=printf
```

```
lineno=8
```

```
parenthesis=(
```

```
lineno=8
```

```
control string="b is greater"
```

```
lineno=8
```

```
parenthesis=)
```

```
lineno=8
```

```
special symbols =;
```

```
lineno=8
```

```
parenthesis=}
```

```
lineno=9
```

4. ELIMINATION OF IMMEDIATE LEFT RECURSION

```
//leftrec.c
#include<stdio.h>
#include<string.h>
char alpha[20]={0};
char beta[20]={0};
char gram[30]={0};
int i=0,j=0,k=0;
void addToBeta(char);
void addToAlpha(char);
void ELR()
{
for(i=0;gram[i]!='\0';i++)
if(gram[i]=='>')
break;
for(i=i+1;gram[i]!='\0';i++)
{
if(gram[i]==gram[0])
{
for(i=i+1;gram[i]!='\0'&&gram[i]!='|';i++)
addToAlpha(gram[i]);
addToAlpha(';');
}
else
{
for(;gram[i]!='\0'&&gram[i]!='|';i++)
addToBeta(gram[i]);
addToBeta(';');
}
}
alpha[j]='\0';
beta[k]='\0';
}
void addToAlpha(char ch)
{
alpha[j]=ch;
j++;
}
void addToBeta(char ch)
{
beta[k]=ch; k++;
}
int main()
{
printf("\nEnter the grammar:\n"); scanf("%s",gram);
ELR();
if(strlen(alpha)==0)
{
printf("\nThe grammar is not left recursive");
return 0;
}
else
{
printf("\nThe grammar after eliminating left recursion is:\n");
printf("\n%c->",gram[0]);
for(i=0;beta[i+1]!='\0';i++)
{
```

```

if(beta[i]==';')
printf("X|");
else
printf("%c",beta[i]);
}
printf("X");
printf("\nX->");
for(i=0;alpha[i+1]!='\0';i++)
{
if(alpha[i]==';')
printf("X|");
else
printf("%c",alpha[i]);
}
printf("X|%s",”Epsilon”);
return 0;
}
}

```

Output:

```

$ cc leftrec.c
$ ./a.out

```

enter the grammer:

T->T*F|F

The grammer after eliminating left recursion is: T->FX

X->*FX|Epsilon

5. LEFT FACTORING A GIVEN GRAMMAR

```
//leftfact.c
#include<stdio.h>
#include<string.h>
char a[30];
char b[30];
char g[30];
char gr[30];
char p1[30];
char p2[30];
char gam[30];

void left()
{
    int i=0,j=0,k=0,l=0,m=0,len2;
    while(gr[i]!='>')
        i++;
    for(i=i+1;gr[i]!='|';i++)
        p1[j++]=gr[i];
    p1[j]='\0';
    j=0;
    for(i=i+1;gr[i]!='\0';i++)
        p2[j++]=gr[i];
    p2[j]='\0';
    l=strlen(p2);
    for(i=0;p2[i]!='\0';i++)
        if(p2[i]=='|')
            break;
    if(i<l)
    {
        printf("Gamma part is there\n");
        j=0;
        for(m=0;m<i;m++)
            p2[j++]=p2[m];
        p2[j]='\0';
        j=0;
        for(m=i+1;m<l;m++)
            gam[j++]=p2[m];
        gam[j]='\0';
        printf("Gamma is %s\n",gam);
    }
    else
        printf("Gamma part is not there\n");
    while(p1[k]==p2[k])
        k++;
    j=0;
    for(i=0;i<k;i++)
        a[j++]=p2[i];
    a[j]='\0';
    j=0;
    for(i=k;p1[i]!='\0';i++)
        b[j++]=p1[i];
    b[j]='\0';
    j=0;
    for(i=k;p2[i]!='\0';i++)
        g[j++]=p2[i];
    g[j]='\0';
}
```

```

int main()
{
int len;
printf("\n enter the grammar with atmost three productions where only the first two productions have a common prefix :\n");
scanf("%s",gr);
left();
len=strlen(gam);
printf("left factored grammar is:\n");
if(len)
printf("%c->%sX|%s\n",gr[0],a,gam);
else
printf("%c->%sX\n",gr[0],a);
printf("X->%s|%s\n",b,g);
return 0;
}

```

Output:

```

$ cc leftfact.c
$ ./a.out

```

```

enter the grammar with atmost three productions where only the first two productions have a common prefix :
S->abA|abB|cd
Gamma part is there
Gamma is cd
left factored grammar is:
S->abX|cd
X->A|B

```

```

enter the grammar with atmost three productions where only the first two productions have a common prefix :
S->aA|aB
Gamma part is not there left
factored grammar is:
S->aX
X->A|B

```

```

enter the grammar with atmost three productions where only the first two productions have a common prefix :
S->aA|aB|c
Gamma part is there
Gamma is c
left factored grammar is:
S->aX|c
X->A|B

```

6. TOP DOWN PARSERS

a. Recursive descent parser (Grammar 1)

```
//recursive.c

#include<stdio.h>
void E();
void E1();
void T();
void T1();
void F();
void match(char);
int flag=1;
char ch,t;
int main()
{
printf("The grammer is\n");
printf("E-->E+T|T\nT-->T*F|F\nF-->i\n");
printf("The elimination of left recursion is needed for implementing recersive descent parser\n");
printf("The grammer after elimination of left recursion is\n");
printf("E-->TE\nE'-->+TE|s\nT-->FT\nT'-->*FT|s\nF-->i\n", "Epsilon", "Epsilon");
printf("enter input string and end the string with $\n");
scanf("%c",&ch); E();
if((ch=='$')&&(flag!=0))
printf("successful\n");
else
printf("unsuccessful\n");
}
void match(char t)
{
if(ch==t)
scanf("%c",&ch);
else
flag=0;
}
void E()
{
T();
E1();
}
void E1()
{
if(ch=='+')
{
match('+');
T();
E1();
}
else
return;
}
void T()
{
F();
T1();
}
void T1()
{
if(ch=='*')
```

```

{
match('*');
F();
T1();
}
else
return;
}
void F()
{
match('i');
}

```

Output:

```

$ cc recursive.c
$ ./a.out

```

The grammer is
 $E \rightarrow E+T|T$
 $T \rightarrow T*F|F$
 $F \rightarrow i$

The elimination of left recursion is needed for implementing recursive descent parser
arser
The grammer after elimination of left recursion is

```

E-->TE'
E'-->+TE'|Epsilon
T-->FT'
T'-->*FT'|Epsilon
F-->i

```

enter input string and end the string with \$

```

i*i+i$
successful

```

```

$ ./a.out

```

The grammer is
 $E \rightarrow E+T|T$
 $T \rightarrow T*F|F$
 $F \rightarrow i$

The elimination of left recursion is needed for implementing recursive descent parser
arser
The grammer after elimination of left recursion is

```

E-->TE'
E'-->+TE'|Epsilon
T-->FT'
T'-->*FT'|Epsilon
F-->i

```

enter input string and end the string with \$

```

i$
successful

```


\$./a.out

The grammer is

$E \rightarrow E+T \mid T$

$T \rightarrow T*F \mid F$

$F \rightarrow i$

The elimination of left recursion is needed for implementing recursive descent parser

The grammer after elimination of left recursion is

$E \rightarrow TE'$

$E' \rightarrow +TE' \mid \text{Epsilon}$

$T \rightarrow FT'$

$T' \rightarrow *FT' \mid \text{Epsilon}$

$F \rightarrow i$

enter input string and end the string with \$

i+i\$

successful

b. Recursive descent parser (Grammar 2)

```
//recursive2.c
#include<stdio.h>
void E();
void T();
void match(char);
int flag=1;
char ch,t;
int main()
{
printf("The grammer is\n");
printf("E-->x+T\nT-->(E)x\n");
printf("enter input string and end with dollar\n");
scanf("%c",&ch);
E();
if((ch=='$')&&(flag!=0))
printf("successful\n");
else
printf("unsuccessful\n");
}
void match(char t)
{
if(ch==t)
scanf("%c",&ch);
else
flag=0;
}
void E()
{
if(ch=='x') {
match('x');
match('+');
T(); }
}
void T()
{
if(ch=='(')
{
match('(');
E();
match(')');
}
else
match('x');
}
}
```

Output:

```
$ cc recursive2.c  
$ ./a.out
```

The grammer is

```
E-->x+T  
T-->(E)|x
```

enter input string and end with dollar

```
x+(x+x)$  
successful
```

```
$ ./a.out
```

The grammer is

```
T-->(E)|x
```

enter input string and end with dollar

```
(x)$
```

unsuccessful

```
$ ./a.out
```

The grammer is

```
E-->x+T  
T-->(E)|x
```

enter input string and end with dollar

```
x+x$
```

successful

7. CONSTRUCTION OF LR(0) ITEMS

```
#include<stdio.h>
#include<string.h>
main()
{
char A[10][10],items[20][20]={ };
int i,j,k,l=0,m=0,p=3,n=0,ilen[10];
char c,ch;
int flag=0,numprods,temp,temp1,q;
printf("Enter the number of productions\n");
scanf("%d",&numprods);
printf("Enter productions:\n");
for(i=0;i<=numprods;i++)
{
    gets(A[i]);
}

//Finding items

for(i=0;i<=numprods;i++)
{
    n=strlen(A[i]);
    for(j=0;j<(n-2);j++)
    {
        for(k=0;k<=strlen(A[i]);k++)
        {
            if(p==k)
            {
                items[l][m]='.';
                m++;
                items[l][m]=A[i][k];
                m++;
            }
            else
            {
                items[l][m++]=A[i][k];
            }
        }
        l++;
        p++;
        m=0;
    }
    p=3;
}
i=0;
printf("Items are:\n");
while(l!=i)
{
    printf("%d",i);
    puts(items[i]);
    printf("\n");
    i++;
}
}
```

Output:

\$./a.out

Enter the number of productions

3

Enter productions:

S->BC

B->a

C->b

Items are:

0)S->.BC

1)S->B.C

2)S->BC.

3)B->.a

4)B->a.

5)C->.b

6)C->b.

8. EVALUATION OF AN EXPRESSION USING YACC

```
//exp_ev.y
%{
#include<stdio.h>
#include<ctype.h>
#define YYSTYPE double
%}
%token NUM
%left '+' '-'
%left '*' '/'
%right UMINUS
%%
lines:lines expr'\n' {printf("%g\n", $2);}
|lines'\n'
/*empty*/
;
expr:expr'+expr' {$$=$1+$3;}
|expr'-expr' {$$=$1-$3;}
|expr'*expr' {$$=$1*$3;}
|expr'/expr' {$$=$1/$3;}
|('(expr)') {$$=$2;}
|'-expr %prec UMINUS {$$=-$2;}
|NUM
;
%%

main()
{
yyparse();
}
void yyerror(char *s)
{
printf("\nerror\n");
}
yylex()
{
char c;
while((c=getchar())!=' ');
if((c=='.')||(isdigit(c)))
{
ungetc(c, stdin);
scanf("%lf", &yylval);
return NUM;
}
return c;
}
```

Output:

```
$ yacc exp_ev.y
$ cc y.tab.c -ly
$ ./a.out
```

```
2*(3+7)
20
15/(5-2)
5
```

9. INTERMEDIATE CODE GENERATION USING YACC (3 ADDRESS CODE)

```
//three.y

%{
#include<stdio.h>
#include<ctype.h>
int i;
%}

%token id
%%
L:id='E '\n' {printf("%c=%c\n",$1,$3);}
|
;

E:E+'T' {$$='p'; printf("%c=%c+%c\n",$$,$1,$3);}
|E-'T' {$$='r'; printf("%c=%c-%c\n",$$,$1,$3);}
|T
;

T:T'*F' {$$='q'; printf("%c=%c*%c\n",$$,$1,$3);}
|T/'F' {$$='s'; printf("%c=%c/%c\n",$$,$1,$3);}
|F
;

F:'-'G {$$='t'; printf("%c=-%c\n",$$,$2);}
|G
;

G:id{$$=$1;}
;
%%

#include"lex.yy.c"
main()
{
printf("Three Address Code is:\n");
yyparse();
}

void yyerror(char *s)
{
printf("\nerror!!\n");
}
```

```
//lexip.l
opr [*+/-=]

%%
[\\t]. { }
[a-zA-Z]* { sscanf(yytext,"%c",&yy1val);return id;}
[\\n] { return(yytext[0]);}
{ opr } { return(yytext[0]);}

%%

yywrap()
{
return 1;
}
```

Output:

```
$ lex lexip.l
$ yacc three.y
$ cc y.tab.c -ly
$ ./a.out
```

Three Address Code is:

```
a=b/c+d*e-f*g
s=b/c
q=d*e
p=s+q
q=f*g
r=p-q
a=r
```


10. CODE GENERATION (SINGLE AND DOUBLE ADDRESS)

```
//codegen.c
#include<stdio.h>
int main()
{
int i=0,ch,k=3;
char a[100];
printf("\n enter a string:");
scanf("%s",a);
printf("\n1.single adress\n 2.Double Adress\n");
printf("Enter choice:");
scanf("%d",&ch);
switch(ch)
{
case 1:
printf("\nLOAD %c\n",a[2]);
while(a[i]!='\0')
{ if(a[i+3]=='+')
printf("\nADD %c\n",a[i+4]);
else
if(a[i+3]=='-')
printf("\nSUB %c\n",a[i+4]);
i=i+2;
}
printf("\nSTORE %c\n",a[0]);
break;
case 2:
while(a[k]!='\0')
{
if(a[k]=='+')
printf("\nADD %c %c\n",a[2],a[k+1]);
else
if(a[k]=='-')
printf("\nSUB %c %c\n",a[2],a[k+1]);
k=k+2;
}
if(a[1]=='=')
printf("\nMOV %c %c\n",a[0],a[2]);
break;
}
}
```

Output:

```
$ cc codegen.c  
$ ./a.out  
enter a string:a=b+c-d
```

```
1.single adress  
2.Double Adress  
Enter choice:2
```

```
ADD b c  
SUB b d  
MOV a b
```

```
$ ./a.out  
enter a string:  
a=b+c-d
```

```
1. single adress  
2.Double Adress  
Enter choice:1
```

```
LOAD b  
ADD c  
SUB d  
STORE a
```

11. TARGET CODE GENERATION

```
//targetcode.c

#include <stdio.h>
#define max 20
static int r=0;
int top=-1;
char st[max];
int main()
{
int h;
char ip[10];
printf("\nenter the postfix expression:");
scanf("%s",ip);
h=0;
while(ip[h]!='\0')
{
while(islower(ip[h])!=0)
{
push(ip[h]);
h++;
}
getregister();
printf("\nload %c R%d\n",st[top-1],r);
switch(ip[h])
{
case '+':
{
printf("\nadd %c R%d\n",st[top],r);
empty();
h++;
}
break;
case '-':
{
printf("\nsub %c R%d\n",st[top],r);
empty();
h++;
}
break;
case '*':
{
printf("\n mul %c R%d\n",st[top],r);
empty();
h++;
}
break;
case '/':
{
printf("\n div %c R%d\n",st[top],r);
empty();
h++;
}
break;
default:
printf("\n invalid choice");
}
}
}
```

```

return 0;
}

empty()
{
char t1;
pop();
pop();
printf("\n st R%d t\n",r);
t1='t';
push(t1);
}
getregister()
{
r++;
if(r>2)
r=1;
}
push(int x)
{
if(top==max-1)
printf("\n stack full\n");
else
{
top++;
st[top]=x;
}
}

pop()
{
if(top==-1)
printf("\n stack empty\n");
else
top--;
}

```

Output:

```

$ cc targetcode.c
$ ./a.out
enter the postfix expression: abc/+
load b R1
div c R1
st R1 t
load a R2
add t R2
st R2 t

$ ./a.out
enter the postfix expression:abcd+/*
load c R1
add d R1
st R1 t
load b R2
div t R2
st R2 t
load a R1
mul t R1
st R1 t

```

12. CODE OPTIMIZATION

```
//optimize.c
#include<stdio.h>
#include<string.h>
void main()
{
char str[25][50],op[25][50],forloopparam[90],righthandparam[10][40],lefthandparam[90];
int i=0,k=0,j=0,m=0,n=0,q=0,s=0,l=0;
int flag[10]={0},count[10]={0};
printf("\n input the loop to be optimised:\n");
gets(str[0]);
while(str[k][i++]!=';');
while(str[k][i++]!=';');
while(str[k][i]!='')
{
if(isalpha(str[k][i]))
forloopparam[j++]=str[k][i];
i++;
}
i=0;
strcpy(op[l++],str[0]);
gets(str[0]);
while(str[0][i++]!='{');
strcpy(op[l++],str[0]); k=0;
while(gets(str[k])&&str[k][0]!='}')
{
while(str[k][i++]!='=');
lefthandparam[n++]=str[k][i-2];
k++;
i=0;
}
for(m=0,i=0;m<k;m++)
{
while(str[m][i++]!='=');
while(str[m][i]!=';')
{
if(isalpha(str[m][i]))
righthandparam[m][count[m]++]=str[m][i];
i++;
}
i=0;
}
for(m=0;m<k;m++)
for(s=0;s<count[m];s++)
for(i=0;i<n;i++)
{
if(righthandparam[m][s]==lefthandparam[i])
flag[m]=1;
}
for(i=0;i<k;i++)
for(q=0;q<j;q++)
{
if(lefthandparam[i]==forloopparam[q])
flag[i]=1;
}
for(m=1;m<k;m++)
for(s=0;s<count[m];s++)
for(i=0;i<j;i++)
{
```

```
if(righthandparam[m][s]==forloopparam[i])
flag[m]=1;
}
printf("\n\noptimised loop is\n"); for(i=0;i<1;i++)
puts(op[i]);
for(i=0;i<k;i++)
if(flag[i]==1)
puts(str[i]);
puts(str[k]); for(i=0;i<k;i++)
if(flag[i]==0)
printf("%s\t\n",str[i]);
}
```

Output:

```
$ cc optimize.c
```

```
$ ./a.out
```

input the loop to be optimised:

```
for(i=0;i<3;i++)
{
i=i+1;
c=a+b;
}
```

optimised loop is

```
for(i=0;i<3;i++)
{
i=i+1;
}
c=a+b;
```