2. Write a Lex Program to implement a Lexical Analyzer using Lex tool.

```
/* LEX Program to recognize tokens */
%{
#include<stdio.h>
%}
DIGIT [0-9]
LETTER [A-Z a-z]
DELIM [ \t\n]
WS { DELIM }+
ID {(LETTER)[LETTER/DIGIT]}+
INTEGER {DIGIT}+
%%
{WS} { printf("\n WS special characters \n"); }
{ID} { printf("\n Identifiers \n"); }
{DIGIT} {printf("\n Intgers\n"); }
 if { printf("\n Keywords\n"); }
 else { printf("\n keywords\n"); }
 ">" { printf("\n Relational Operators\n"); }
 "<" { printf("\n Relational Operators \n"); }
 "<=" { printf("\n Relational Operators \n"); }
 "=>" { printf("\n Relational Operators \n"); }
 "=" { printf("\n Relational Operators \n"); }
 "!=" { printf("\n Logical Operators \n"); }
 "&&" { printf("\n Logical Operators \n"); }
 "||" { printf("\n Logical Operators \n"); }
 "!" { printf("\n Logical Operators \n"); }
 "+" { printf("\n Arthmetic Operator\n"); }
 "-" { printf("\n Arthmetic Operator\n"); }
 "*" { printf("\n Arthmetic Operator\n"); }
 "/" { printf("\n Arthmetic Operator\n"); }
 "%" { printf("\n Arthmetic Operator\n"); }
%%
int yywrap(){ }
int main()
{
Printf(‘’ Enter the text : ’’)
 yylex();
return 0 ;
 }
```

4. Write a C program to implement the Brute force technique of Top down Parsing.

Program:-

```
#include<stdio.h>
char c[10];
int i=0;
main()
{
clrscr();
printf("\n enter input string");
scanf("%s",c);
if(s()==0)
printf("the given input string is not valid");
else
printf("the given input string is valid");
getch();
}
int s()
{
if(c[i]=='c')
{
advance();
if(A())
{
if(c[i]=='d')
{
advance();
return 1;
}
}
}
return 0;
}
advance()
{
i=i+1;
}
int A()
{
int isave;
{
isave=1;
if(c[i]=='a');
{
advance();
if(c[i]=='b')
{
advance();
```

```
return 1;
}
}
i=isave;
if(c[i]=='a')
{
advance();
return 1;
}
return 0;
}
}
```

output:

```
 enter input string   cad
the given input string is valid
```

5. Write a C program to implement a Recursive Descent Parser.
PROGRAM:

```
#include<stdio.h>
char c[10];
int isym=0,flag=0;
main()
{
clrscr();
printf("\n enter the input string");
scanf("%s",c);
E();
if(flag==1)
printf("notvalid");
else
printf("valid");
getch();
}
E()
{
T();
eprime();
}
eprime()
{
if(c[isym]=='+')
{
advance();
T();
eprime();
}
}
T()
{
F();
tprime();
}
F()
{
if(c[isym]=='i')
{
advance();
if(c[isym]=='i')
error();
}
else
if(c[isym]=='c')
```

```
{
advance();
E();
if(c[isym]==')')
advance();
else
error();
}
else
error();
}
tprime()
{
if(c[isym]=='*')
{
advance();
F();
tprime();
}
}
advance()
{
isym++;
}
error()
{
flag=1;
}
```

Output:

```
 enter the input stringi*i+i
valid

 enter the input stringi(i)
valid

enter the input stringi*i+c
notvalid
```

6(a). PROGRAM FOR COMPUTATION OF FIRST

```
#include<stdio.h>
#include<conio.h>
#include<string.h>
void main()
{
        char t[5],nt[10],p[5][5],first[5][5],temp;
        int i,j,not,nont,k=0,f=0;
        clrscr();
        printf("\nEnter the no. of Non-terminals in the grammar: ");
        scanf("%d",&nont);
        printf("\nEnter the Non-terminals in the  grammar:\n");
        for(i=0;i<nont;i++)
        {
                scanf("\n%c",&nt[i]);
        }
        printf("\nEnter the no. of Terminals in the grammar (Enter e for epsilon): ");
        scanf("%d",&not);
        printf("\nEnter the Terminals in the grammar:\n");
        for(i=0;i<not||t[i]=='$';i++)
        {
                scanf("\n%c",&t[i]);
        }
        for(i=0;i<nont;i++)
        {
                p[i][0]=nt[i];
                first[i][0]=nt[i];
        }
        printf("\nEnter the productions :\n");
        for(i=0;i<nont;i++)
        {
                scanf("%c",&temp);
                printf("\nEnter the production for %c ( End the production with '$' sign ):
      ",p[i][0]);
                for(j=0;p[i][j]!='$';)
                {
                        j+=1;
                        scanf("%c",&p[i][j]);
                }
        }
        for(i=0;i<nont;i++)
        {
                printf("\nThe production for %c -> ",p[i][0]);
                for(j=1;p[i][j]!='$';j++)
                {
```

```
                printf("%c",p[i][j]);
            }
        }
        for(i=0;i<nont;i++)
        {
            f=0;
            for(j=1;p[i][j]!='$';j++)
            {
                for(k=0;k<not;k++)
                {
                    if(f==1)
                    break;

                    if(p[i][j]==t[k])
                    {
                        first[i][j]=t[k];
                        first[i][j+1]='$';
                        f=1;
                        break;
                    }
                    else if(p[i][j]==nt[k])
                    {
                        first[i][j]=first[k][j];
                        if(first[i][j]=='e')
                            continue;
                        first[i][j+1]='$';
                        f=1;
                        break;
                    }
                }
            }
        }
        for(i=0;i<nont;i++)
        {
            printf("\nThe first of %c -> ",first[i][0]);
            for(j=1;first[i][j]!='$';j++)
            {
                printf("%c\t",first[i][j]);
            }
        }
getch();
}
```

OUTPUT

```
Enter the no. of Non-terminals in the grammar: 3
Enter the Non-terminals in the grammar: ERT
Enter the no. of Terminals in the grammar (Enter e for epsilon): 5
Enter the Terminals in the grammar: ase*+
Enter the productions :
Enter the production for E ( End the production with '$' sign ): a+s$
Enter the production for R ( End the production with '$' sign ): e$
Enter the production for T ( End the production with '$' sign ): Rs$
The production for E -> a+s
The production for R -> e
The production for T -> Rs
The first of E -> a
The first of R -> e
The first of T -> e s
```

6(b)Write a C program to find follow of a given grammar

```
#include<stdio.h>
#include<string.h>
int n,m=0,p,i=0,j=0;
char a[10][10],followResult[10];
void follow(char c);
void first(char c);
void addToResult(char);
int main()
{
 int i;
 int choice;
 char c,ch;
 printf("Enter the no.of productions: ");
scanf("%d", &n);
 printf(" Enter %d productions\nProduction with multiple terms should be give as separate productions \n", n);
 for(i=0;i<n;i++)
  scanf("%s%c",a[i],&ch);
    // gets(a[i]);
 do
 {
  m=0;
  printf("Find FOLLOW of -->");
  scanf(" %c",&c);
  follow(c);
  printf("FOLLOW(%c) = { ",c);
  for(i=0;i<m;i++)
   printf("%c ",followResult[i]);
  printf(" }\n");
  printf("Do you want to continue(Press 1 to continue....)?");
 scanf("%d%c",&choice,&ch);
 }
 while(choice==1);
}
void follow(char c)
{
    if(a[0][0]==c)
addToResult('$');
 for(i=0;i<n;i++)
 {
  for(j=2;j<strlen(a[i]);j++)
  {
   if(a[i][j]==c)
   {
    if(a[i][j+1]!='\0')
    first(a[i][j+1]);
    if(a[i][j+1]=='\0'&&c!=a[i][0])
```

```
    follow(a[i][0]);
  }
 }
}
}
void first(char c)
{
     int k;
            if(!(isupper(c)))
               //f[m++]=c;
               addToResult(c);
            for(k=0;k<n;k++)
            {
            if(a[k][0]==c)
            {
            if(a[k][2]=='$') follow(a[i][0]);
            else if(islower(a[k][2]))
               //f[m++]=a[k][2];
               addToResult(a[k][2]);
            else first(a[k][2]);
            }
            }
}
void  addToResult(char c)
{
   int i;
   for( i=0;i<=m;i++)
      if(followResult[i]==c)
         return;
  followResult[m++]=c;
}
```

```
Enter the no.of productions: 8
 Enter 8 productions
Production with multiple terms should be give as separate productions
E=TD
D=+TD
D=$
T=FS
S=*FS
S=$
F=(E)
F=a
Find FOLLOW of -->E
FOLLOW(E) = { $ )  }
Do you want to continue(Press 1 to continue....)?1
Find FOLLOW of -->D
FOLLOW(D) = { )  }
Do you want to continue(Press 1 to continue....)?1
Find FOLLOW of -->T
FOLLOW(T) = { + $ )  }
Do you want to continue(Press 1 to continue....)?S
Find FOLLOW of -->FOLLOW(S) = { $ )  }
Do you want to continue(Press 1 to continue....)?1
Find FOLLOW of -->F
FOLLOW(F) = { * + $ )  }
Do you want to continue(Press 1 to continue....)?
```

7a) Write a C program for eliminating the left recursion of a given grammar

What is left recursion?

Left Recursion:

Consider,

E->E+T

E=a

T=b

In it's parse tree E will grow left indefinitely, so to remove it

E=Ea | b

we take as

E=bE'

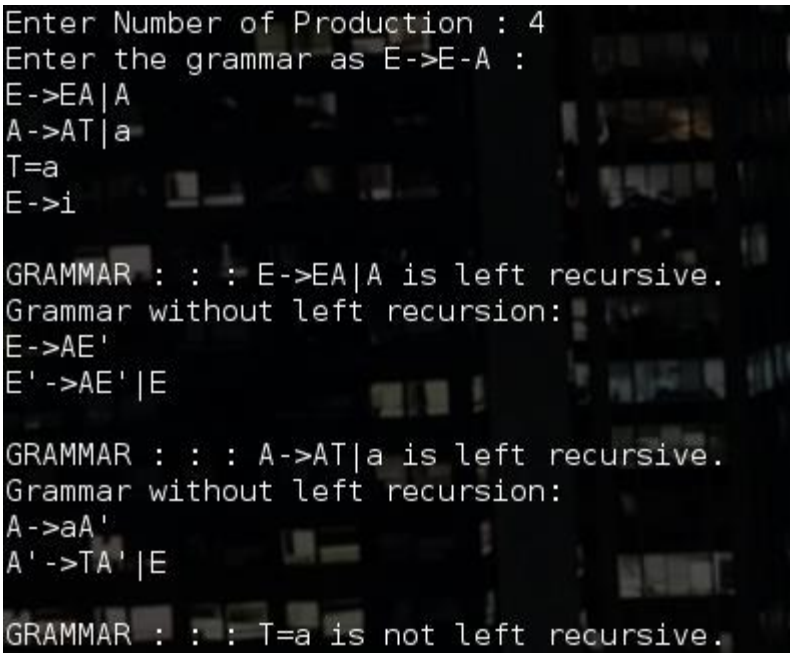
E'= aE'|E

Program :

```
#include<stdio.h>
#include<string.h>
#define SIZE 10
int main ()
{
  char non_terminal;
  char beta,alpha;
  int num;
  char production[10][SIZE];
  int index=3; /* starting of the string following "->" */
  printf("Enter Number of Production : ");
  scanf("%d",&num);
  printf("Enter the grammar as E->E-A :\n");
  for(int i=0;i<num;i++)
  {
       scanf("%s",production[i]);
  }
  for(int i=0;i<num;i++)
 {
      printf("\nGRAMMAR : : : %s",production[i]);
      non_terminal=production[i][0];
      if(non_terminal==production[i][index])
     {
        alpha=production[i][index+1];
        printf(" is left recursive.\n");
        while(production[i][index]!=0 && production[i][index]!='|')
           index++;
        if(production[i][index]!=0)
       {
           beta=production[i][index+1];
           printf("Grammar without left recursion:\n");
           printf("%c->%c%c\'",non_terminal,beta,non_terminal);
```

```
            printf("\n%c\'->%c%c\'|E\n",non_terminal,alpha,non_terminal);
        }
        else
            printf(" can't be reduced\n");
      }
      else
        printf(" is not left recursive.\n");
      index=3;
    }
}
```

OUTPUT:



7 b) Write a C program for eliminating the left factoring of a given grammar

In LL(1) Parser in Compiler Design, Even if a context-free grammar is unambiguous and non-left-recursion it still cannot be a LL(1) Parser. That is because of Left Factoring.

What is Left Factoring?
Consider a part of regular grammar,

E->aE+bcD
E->aE+cBD

Here, grammar is non-left recursive, and unambiguous but there is left factoring.

How to resolve?
E=aB | aC | aD | .....

then,
E=aX
X=B | C | D |.....

So, the above grammar will be as :
E=aE+X
X=bcD | cBD

Program:

```
#include<stdio.h>
#include<string.h>
int main()
{
   char gram[20],part1[20],part2[20],modifiedGram[20],newGram[20],tempGram[20];
   int i,j=0,k=0,l=0,pos;
   printf("Enter Production: A->");
   gets(gram);
   for(i=0;gram[i]!='|';i++,j++)
      part1[j]=gram[i];
   part1[j]='\0';
   for(j=++i,i=0;gram[j]!='\0';j++,i++)
      part2[i]=gram[j];
   part2[i]='\0';
   for(i=0;i<strlen(part1)||i<strlen(part2);i++){
      if(part1[i]==part2[i]){
         modifiedGram[k]=part1[i];
         k++;
         pos=i+1;
      }
   }
   for(i=pos,j=0;part1[i]!='\0';i++,j++){
      newGram[j]=part1[i];
   }
```

```
    newGram[j++]='|';
    for(i=pos;part2[i]!='\0';i++,j++){
        newGram[j]=part2[i];
    }
    modifiedGram[k]='X';
    modifiedGram[++k]='\0';
    newGram[j]='\0';
    printf("\nGrammar without Left Factoring: \n");
    printf(" A->%s",modifiedGram);
    printf("\n X->%s\n",newGram);
}
```

OUTPUT:

```
Enter Production: A->bE+acF|bE+f
Grammar without Left Factoring:
A-> bE+X
X-> acF|f
```

8. Write a C program to check the validity of input string using Predictive Parser.

```
/*program to implement PREDICTIVE PARSER */
#include<stdio.h>
int stack[20],top=-1;
void push(int item)
{
  if(top>=20)
  {
   printf("STACK OVERFLOW");
   exit(1);
  }
  stack[++top]=item;
 }
 int pop()
 {
   int ch;
   if(top<=-1)
   {
     printf("underflow");
     exit(1);
   }
   ch=stack[top--];
   return ch;
}
char convert(int item)
{
  char ch;
  switch(item)
  {
    case 0:return('E');
    case 1:return('e');
    case 2:return('T');
    case 3:return('t');
    case 4:return('F');
    case 5:return('i');
    case 6:return('+');
    case 7:return('*');
    case 8:return('(');
    case 9:return(')');
    case 10:return('$');
  }
}
void main()
{
  int m[10][10],i,j,k;
  char ips[20];
  int ip[10],a,b,t;
  m[0][0]=m[0][3]=21;
  m[1][1]=621;
  m[1][4]=m[1][5]=-2;
  m[2][0]=m[2][3]=43;
  m[3][1]=m[3][4]=m[3][5]=-2;
  m[3][2]=743;
  m[4][0]=5;
  m[4][3]=809;
  clrscr();
  printf("\n enter the input string:");
  scanf("%s",ips);
  for(i=0;ips[i];i++)
  {
```

```
   switch(ips[i])
   {
   case 'E':k=0;break;
   case 'e':k=1;break;
   case 'T':k=2;break;
   case 't':k=3;break;
   case 'F':k=4;break;
   case 'i':k=5;break;
   case '+':k=6;break;
   case '*':k=7;break;
   case '(':k=8;break;
   case ')':k=9;break;
   case '$':k=10;break;
 }
 ip[i]=k;
}
ip[i]=-1;
push(10);
push(0);
i=0;
printf("\tstack\t       input \n");
while(1)
{
  printf("\t");
  for(j=0;j<=top;j++)
  printf("%c",convert(stack[j]));
  printf("\t\t");
  for(k=i;ip[k]!=-1;k++)
  printf("%c",convert(ip[k]));
  printf("\n");
  if(stack[top]==ip[i])

  {
   if(ip[i]==10)
   {
         printf("\t\t SUCCESS");
         return;
   }
   else
  {
    top--;
    i++;
  }
 }
 else if(stack[top]<=4&&stack[top]>=0)
  {
    a=stack[top];
    b=ip[i]-5;
    t=m[a][b];
    top--;
    while(t>0)
         {
          push(t%10);
          t=t/10;
    }
    }
    else
    {
         printf("ERROR");
         return;
```

```
    }
   }
  getch();
}
```

OUTPUT:

enter the string:i+(i*i)$

stack	input
$E	i+(i*i)$
$eT	i+(i*i)$
$etF	i+(i*i)$
$eti	i+(i*i)$
$et	+(i*i)$
$e	+(i*i)$
$eT+	+(i*i)$
$eT	(i*i)$
$etF	(i*i)$
$et)E(	(i*i)$
$et)E	i*i)$
$et)eT	i*i)$
$et)etF	i*i)$
$et)eti	i*i)$
$et)et	*i)$
$et)etF*	*i)$
$et)etF	i)$
$et)eti	i)$
$et)et	)$
$et)e	)$
$et)	)$
$et	$
$e	$
$	$

9. Write a C program for implementation of LR parsing algorithm to accept a given input string.

```
/* Program to Implement SLR Parsing */
#include<stdio.h>
#include<string.h>
int axn[][6][2]={
        {{100,5},{-1,-1},{-1,-1},{100,4},{-1,-1},{-1,-1}},
        {{-1,-1},{100,6},{-1,-1},{-1,-1},{-1,-1},{102,102}},
        {{-1,-1},{101,2},{100,7},{-1,-1},{101,2},{101,2}},
        {{-1,-1},{101,4},{101,4},{-1,-1},{101,4},{101,4}},
        {{100,5},{-1,-1},{-1,-1},{100,4},{-1,-1},{-1,-1}},
        {{-1,-1},{101,6},{101,6},{-1,-1},{101,6},{101,6}},
        {{100,5},{-1,-1},{-1,-1},{100,4},{-1,-1},{-1,-1}},
        {{100,5},{-1,-1},{-1,-1},{100,4},{-1,-1},{-1,-1}},
        {{-1,-1},{100,6},{-1,-1},{-1,-1},{100,1},{-1,-1}},
        {{-1,-1},{101,1},{100,7},{-1,-1},{101,1},{101,1}},
        {{-1,-1},{101,3},{101,3},{-1,-1},{101,3},{101,3}},
        {{-1,-1},{101,5},{101,5},{-1,-1},{101,5},{101,5}}
};//Axn Table

int   gotot[12][3]={1,2,3,-1,-1,-1,-1,-1,-1,-1,-1,-1,8,2,3,-1,-1,-1,-1,9,3,-1,-1,10,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-
1};  //GoTo table

int a[10];
char b[10];
int top=-1,btop=-1,i;

void push(int k)
{
  if(top<9)
    a[++top]=k;
}
void pushb(char k)
{
  if(btop<9)
    b[++btop]=k;
}
char TOS()
{
   return a[top];
}
void pop()
{
   if(top>=0)
     top--;
}
void popb()
{
   if(btop>=0)
     b[btop--]='\0';
}
void display()
{
  for(i=0;i<=top;i++)
    printf("%d%c",a[i],b[i]);
}
```

```
void display1(char p[],int m) //Displays The Present Input String
{
  int l;
  printf("\t\t");
  for(l=m;p[l]!='\0';l++)
    printf("%c",p[l]);
  printf("\n");
}
void error()
{
  printf("Syntax Error");
}
void reduce(int p)
{
   int len,k,ad;
   char src,*dest;
   switch(p)
   {
     case 1: dest="E+T"; src='E';break;
     case 2: dest="T"; src='E'; break;
     case 3: dest="T*F"; src='T'; break;
     case 4: dest="F"; src='T'; break;
     case 5: dest="(E)"; src='F'; break;
     case 6: dest="i"; src='F'; break;
     default: dest="\0"; src='\0'; break;
   }
   for(k=0;k<strlen(dest);k++)
   {
     pop();
     popb();
   }
   pushb(src);
   switch(src)
   {
     case 'E': ad=0;break;
     case 'T': ad=1;break;
     case 'F': ad=2;break;
     default: ad=-1;break;
   }
  push(gotot[TOS()][ad]);
}
int main()
{
   int j,st,ic;
   char ip[20]="\0",an;
   clrscr();
   printf("Enter any String\n");
   scanf("%s",ip);
   printf("STACK\t\tINPUT\n");
   push(0);
   display();
   printf("\t\t%s\n",ip);
   for(j=0;ip[j]!='\0';)
   {
    st=TOS();
```

```
    an=ip[j];
    if(an>='a'&&an<='z') ic=0;
    else if(an=='+') ic=1;
    else if(an=='*') ic=2;
    else if(an=='(') ic=3;
    else if(an==')') ic=4;
    else if(an=='$') ic=5;
    else
    {
     error();
     break;
    }
    if(axn[st][ic][0]==100)
    {
      pushb(an);
      push(axn[st][ic][1]);
      display();
      j++;
      display1(ip,j);
   }
  if(axn[st][ic][0]==101)
  {
   reduce(axn[st][ic][1]);
   display();
   display1(ip,j);
  }
  if(axn[st][ic][1]==102)
  {
      printf("Given String is accepted \n");
      getch();
      break;
  }
}
return 0;
}
```

OUTPUT:

```
Enter any String
a+a*a$
STACK           INPUT
0               a+a*a$
0a5             +a*a$
0F3             +a*a$
0T2             +a*a$
0E1             +a*a$
0E1+6           a*a$
0E1+6a5         *a$
0E1+6F3         *a$
0E1+6T9         *a$
0E1+6T9*7         a$
0E1+6T9*7a5        $
0E1+6T9*7F10       $
0E1+6T9            $
0E1                $
Given String is accepted
```

10. Write a C program for implementation of a Shift Reduce Parser using Stack Data Structure to accept a given input string of a given grammar.

PROGRAM:

```
#include<stdio.h>
#include<conio.h>
char stack[30];
int top=-1;
void push(char c)
{
    top++;
    stack[top]=c;
}
char pop()
{
  char c;
  if(top!=-1)
  {
     c=stack[top];
     top--;
     return c;
  }
return 'x';
}
void printstat()
{
  int i;
  printf("\n$");
  for(i=0;i<=top;i++)
  printf("%c",stack[i]);
}
void main()
{
    int i,j,k,len;
    char s1[20],s2[20],ch1,ch2,ch3;
    clrscr();
    printf("LR PARSING\n");
    printf("ENTER THE EXPRESSION\n");
    scanf("%s",s1);
    len=strlen(s1);
    j=0;
    printf("$");
    for(i=0;i<len;i++)
    {
          if(s1[i]=='i' && s1[i+1]=='d')
          {
                s1[i]=' ';
                s1[i+1]='E';
                printstat(); printf("id");
                push('E');
                printstat();
          }
          else if(s1[i]=='+'||s1[i]=='-'||s1[i]=='*' ||s1[i]=='/' ||s1[i]=='d')
          {
                push(s1[i]);
```

```
                printstat();
            }
        }
    printstat();
    len=strlen(s2);
    while(len)
    {
        ch1=pop();
        if(ch1=='x')
        {
          printf("\n$");
          break;
        }
        if(ch1=='+'||ch1=='/'||ch1=='*'||ch1=='-')
        {
            ch3=pop();
            if(ch3!='E')
            {
                printf("errror");
                exit();
            }
            else
            {
                push('E');
                printstat();
            }
        }
        ch2=ch1;
    }
    getch();
}
```

OUTPUT:

```
LR PARSING
ENTER THE EXPRESSION
id+id*id-id
$
$id
$E
$E+
$E+id
$E+E
$E+E*
$E+E*id
$E+E*E
$E+E*E-
$E+E*E-id
$E+E*E-E
$E+E*E-E
$E+E*E
$E
$
```