K S INSTITUTE OF TECHNOLOGY
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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

SYSTEM SOFTWARE LABORATORY

18CSL66

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K S INSTITUTE OF TECHNOLOGY

VISION

"To impart quality technical education with ethical values, employable skills and research to achieve excellence"

MISSION

- **To attract and retain highly qualified, experienced & committed faculty.**
- **To create relevant infrastructure**
- **Network with industry & premier institutions to encourage emergence of new ideas by providing research & development facilities to strive for academic excellence**
- **To inculcate the professional & ethical values among young students with employable skills & knowledge acquired to transform the society**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

VISION

"To create competent professionals in Computer Science and Engineering with adequate skills to drive the IT industry".

MISSION

- **Impart sound technical knowledge and quest for continuous learning.**
- **To equip students to furnish Computer Applications for the society through experiential learning and research with professional ethics.**
- **Encourage team work through inter-disciplinary project and evolve as leaders with social concerns.**

DEPARTMENT OF
COMPUTER SCIENCE AND ENGINEERING

Program Educational Objectives (PEO's)

PEO1: Excel in professional career by acquiring knowledge in cutting edge Technology and contribute to the society as an excellent employee or as an entrepreneur in the field of Computer Science & Engineering.

PEO2: Continuously enhance their knowledge on par with the development in IT industry and pursue higher studies in computer science &engineering.

PEO3 : Exhibit professionalism, cultural awareness, team work, ethics, and effective communication skills with their knowledge in solving social and environmental problems by applying computer technology.

Program Specific Outcomes (PSO's)

PSO1 : Ability to understand, analyze problems and implement solutions in Programming languages, as well to apply concepts in core areas of Computer Science in association with professional bodies and clubs.

PSO2 : Ability to use computational skills and apply software knowledge to develop effective solutions and data to address real world challenges.

PROGRAM OUTCOMES (PO's)

PO1: Engineering Knowledge: Apply knowledge of mathematics and science, with fundamentals of Computer Science & Engineering to be able to solve complex engineering problems related to CSE.

PO2: Problem Analysis: Identify, Formulate, review research literature and analyze complex engineering problems related to CSE and reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences

PO3: Design/Development of solutions: Design solutions for complex engineering problems related to CSE 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 computer science related 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 CSE professional engineering practice

PO7: Environment and Sustainability: Understand the impact of the CSE 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 able to comprehend and with 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 management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi disciplinary environments

PO12: Life-Long Learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning the broadest context of technological change

SYSTEM SOFTWARE AND OPERATING SYSTEM LABORATORY

1a. Write a LEX program to recognize valid arithmetic expression. Identifiers in the expression could be only integers and operators could be + and *. Count the identifiers & operators present and print them separately.

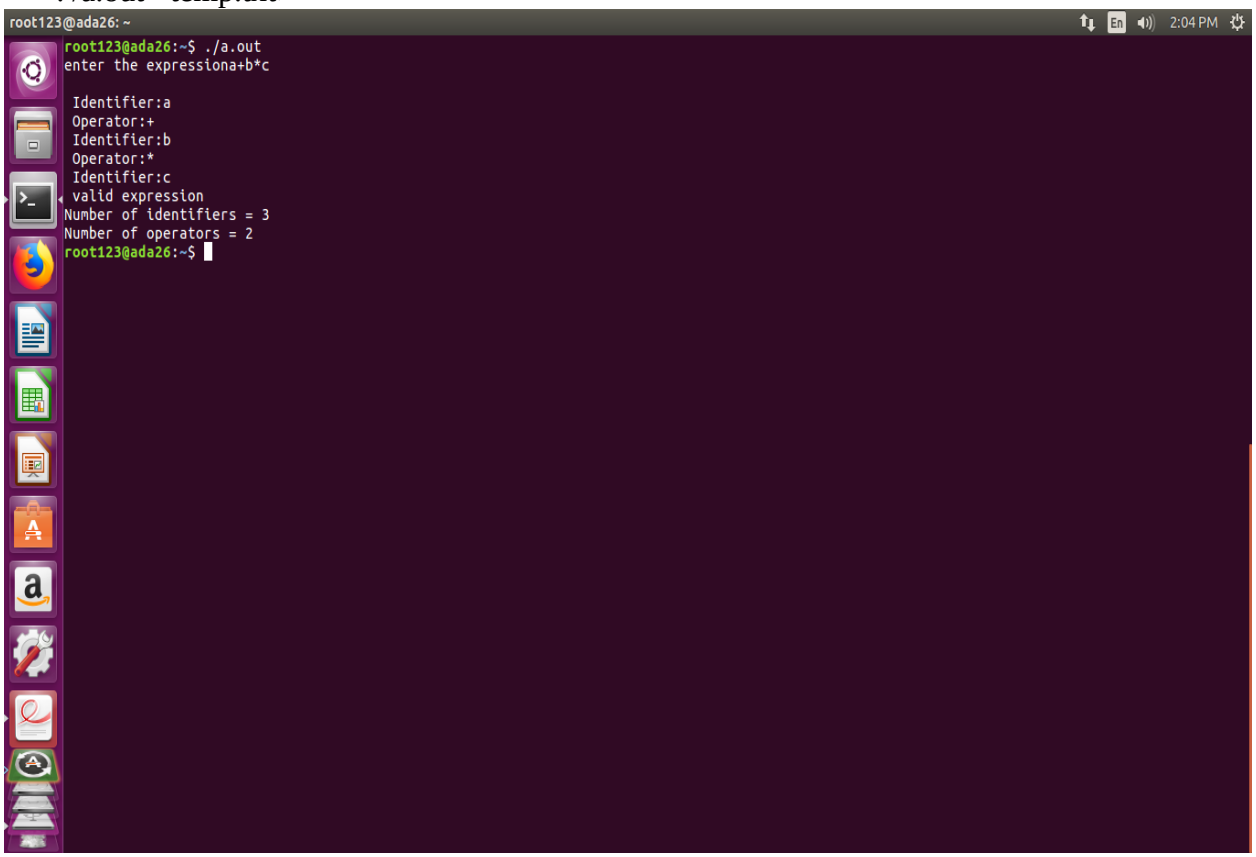
```
%{
#include<stdio.h>
int v=0,op=0,id=0,flag=0;
%}

%%
[a-z A-Z]+[0-9 A-Z a-z]*  {id++;printf("\n Identifier:");ECHO;}
[\+\-\*\/\=]    {op++;printf("\n Operator:");ECHO;}
"("    {v++;}
")"    {v--;}
";"    {flag=1;}
.|\n   {;}
%%

int main()
{
printf("enter the expression");
yylex();

if(((op+1)==id)&&(v==0)&&(flag==0))
{
  printf("\n valid expression\n");
 printf("Number of identifiers = %d\n",id);
 printf("Number of operators = %d\n",op);
}
else
  printf("\n Invalid expression\n");

}
int yywrap()
{
return 1;
}
```

Execution Steps:

Lex <lexfilename.l>

cc lex.yy.c –ll

. /a.out <temp.txt>



b. Write YACC program to evaluate arithmetic expression involving operators:

+, -, * and /

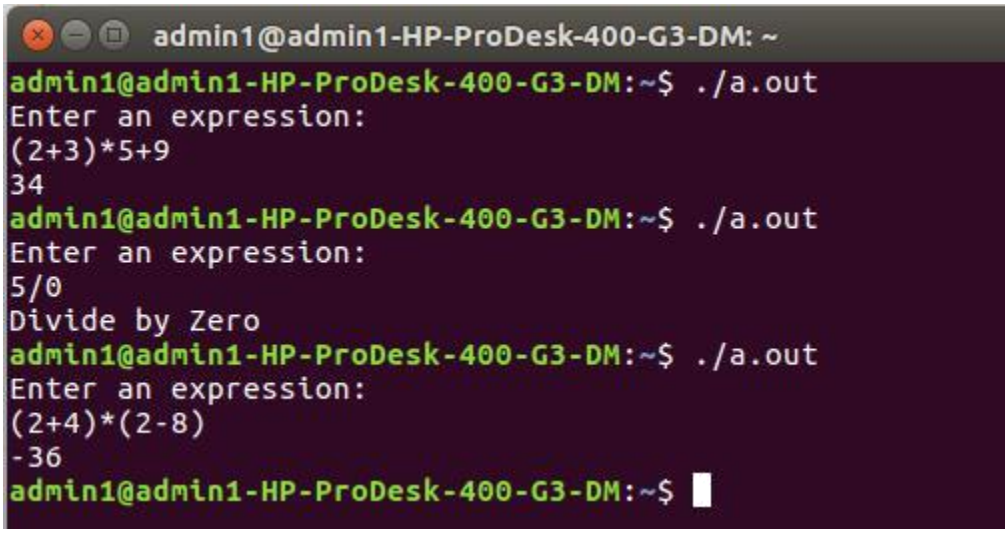
Lex Part

```
%{
#include "y.tab.h"
extern yylval;
%}
%%
[0-9]+ {yylval=atoi(yytext);return num;}  /* convert the
                                            string to number and
                                            send the value*/
[\+\-\*\/] {return yytext[0];}
← {return yytext[0];}
← {return yytext[0];}
. {;}
\n {return 0;}
%%
```

YACC Part

```
%{
#include<stdio.h>
#include<stdlib.h>
%}
%token num
%left '+' '-'
%left '*' '/'
%%
input:exp {printf("%d\n",$$);exit(0);}
exp:exp'+'exp {$$=$1+$3;}
|exp'-'exp{$$=$1-$3;}
|exp'*'exp{$$=$1*$3;}
|exp'/'exp
         { if($3==0){printf("Divide
         by Zero\n");exit(0);} else
          $$=$1/$3;}
|'('exp')'{$$=$2;}
|num{$$=$1;};
%%
int yyerror()
{
printf("error");
exit(0);
}

int main()
{
printf("Enter an expression:\n");
```

```
yyparse();
}
```



2. **Develop, Implement and execute a program using YACC tool to recognize all strings ending with *b* preceded by *n a's* using the grammar $a^n b$ (note: input *n* value).**

Lex Part

```
%{
#include "y.tab.h"
%}
%%
a {return A;}
b {return B;}
[\n] return '\n';
%%
```

YACC Part

```
%{
#include<stdio.h>
#include<stdlib.h>
%}
%token A B
%%
input:s'\n' {printf("Successful Grammar\n");exit(0);}
s: A
s1
B|
B
s1
:
;
|
A
s1
%%
 main()
{
printf("Enter
A String\n");
yyparse();
}

int yyerror()
{
printf("Error \n");
exit(0);
}
```

```
admin1@admin1-HP-ProDesk-400-G3-DM: ~
admin1@admin1-HP-ProDesk-400-G3-DM:~$ ./a.out
Enter A String

Error
admin1@admin1-HP-ProDesk-400-G3-DM:~$ ./a.out
Enter A String
b
Successful Grammar
admin1@admin1-HP-ProDesk-400-G3-DM:~$ ./a.out
Enter A String
```

3. **Design, develop and implement YACC/C program to construct *Predictive / LL(1) Parsing Table* for the grammar rules*: $A \rightarrow aBa$, $B \rightarrow bB \mid \varepsilon$*. Use this table to parse the sentence*: abba$.***

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

  char STACK[20]="\0";
  int TOP=-1,flag=0;
  int B_ptr = 0;
  char BUFFER[20],G_prod[20];
  char table [3][3][10] = {
                "NT", "a","b",
                "A", "aBa","Error",
                "B", "Îµ","bB",
                };
  char pop()
  {
   char ch;
   ch = STACK[TOP--];
   return ch;
  }

  void push(char ch)
  {
   STACK[++TOP] = ch;
  }

  void stack_content()
  {
      if (TOP != -1)
      {
              int i = 0;
             printf("\nstack content: ");
              while(i <= TOP)
              {
                  printf("%c",STACK[i++]);
              }
              printf("\n");
      }
      return;
  }

  int isterm(char c)
  {
   if (c >= 'a' && c <= 'z')
        return 1;
   else
        return 0;
```

```
    }

    int Parser_table(char stack_top,char buf_value,int flag)
    {
     int r,c;
      switch(stack_top)
     {
          case 'A' : r = 1; break;
          case 'B' : if(flag<=5) r = 2; else r = 3;
     }
     switch(buf_value)
     {
          case 'a' : c = 1; break;
          case 'b' : c = 2;
     }

          if (strcmp(table[r][c],"error") == 0)
          return 0;

     if (strcmp(table[r][c],"Îµ") != 0)
     {
          strcpy(G_prod,table[r][c]);
     }
     return 1;
    }

    int main()
    {
            int i,j,stln;
            printf("LL(1)  PARSER  TABLE \n");
          for(i=0;i<3;i++)
              {
                for(j=0;j<3;j++)
                    {
                         printf("%s\t",table[i][j]);
                    }
                    printf("\n");
          }
printf("\n");
printf("ENTER THE STRING into the Buffer and also give a ';' as
the terminator: ");
scanf("%s",BUFFER);
printf("\n THE STRING in the Buffer is %s",BUFFER);

          if(BUFFER[strlen(BUFFER)-1] != ';')
          {
              printf("END OF STRING MARKER SHOULD BE ';'");
```

```
            exit(0);
          }
          push('$');
          push('A');
          while(STACK[TOP] != '$') // Stack is not Empty
         {
             flag++;
               if (STACK[TOP] == BUFFER[B_ptr]) // X is a
               {
                    printf("\n1.The poped item is - %c,",pop());
                    B_ptr++;
printf("\t buffer cont - %.*s",strlen(BUFFER),BUFFER+B_ptr);
               }
               else if(isterm(STACK[TOP])) // is X is terminal
                    {
                        printf("\n2. $ %c",STACK[TOP]);
                        printf("\t Error in Parsing \n");
                    }
               else
if (!Parser_table(STACK[TOP],BUFFER[B_ptr],flag))
printf("3. Error Entry in Parse Table ");
else
if (Parser_table(STACK[TOP],BUFFER[B_ptr],flag))
          {
          if (flag < 6 && strcmp(G_prod,"Îµ") != 0)
          {
          printf("\n4.1 flag = %d, prod id- %s*\t",flag,G_prod);
           pop();
           stln = strlen(G_prod);
           for(i=stln-1;i>=0;i--)
           push(G_prod[i]);
           stack_content();
           }
          else
          {
        stack_content();
        printf("\n4.2 flag = %d  *reduce by %s*",flag,"B->Îµ");
        pop();
        printf("\t buffer content is %c",BUFFER[B_ptr]);
                        }
                    }
               }
          if (STACK[TOP] == '$' && BUFFER[B_ptr] == ';')
     printf("\n** The string is accepted **");
     else
     printf("\n** The string is not accepted **");
```

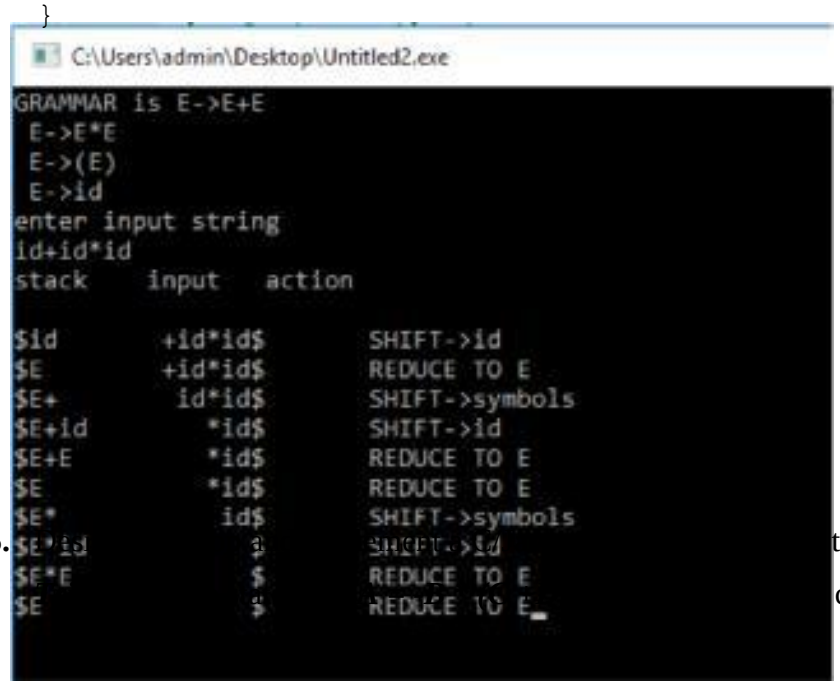
```
}
```

```
LL(1)  PARSER  TABLE
NT      a       b
A       aBa     Error
B       ╬       bB

ENTER THE STRING into the Buffer and also give a ';' as the terminator: abba;

 THE STRING in the Buffer is abba;
4.1 flag = 1, prod id- aBa*
stack content: $aBa

1.The poped item is - a,         buffer cont - bba;
4.1 flag = 3, prod id- bB*
stack content: $aBb

1.The poped item is - b,         buffer cont - ba;
4.1 flag = 5, prod id- bB*
stack content: $aBb

1.The poped item is - b,         buffer cont - a;
stack content: $aB

4.2 flag = 7  *reduce by B->╬*  buffer content is a
1.The poped item is - a,         buffer cont - ;
** The string is accepted **
Process returned 29 (0x1D)   execution time : 3.459 s
Press any key to continue.
```

4. Design, develop and implement YACC/C program to demonstrate ***Shift Reduce Parsing*** technique for the grammar rules: ***E →E+T | T, T →T*F | F, F → (E) | id*** and parse the sentence***: id + id * id***.

```
#include<stdio.h>
#include<conio.h>
#include<string.h>
int k=0,z=0,i=0,j=0,c=0;
char a[16],ac[20],stk[15],act[10];
void check();
void main()
  {
   puts("GRAMMAR is E->E+E \n E->E*E \n E->(E) \n E->id");
   puts("enter input string ");
   gets(a);
   c=strlen(a);
   strcpy(act,"SHIFT->");
   puts("stack \t input \t action");
   for(k=0,i=0; j<c; k++,i++,j++)
    {
     if(a[j]=='i' && a[j+1]=='d')
      {
       stk[i]=a[j];
       stk[i+1]=a[j+1];
       stk[i+2]='\0';
       a[j]=' ';
       a[j+1]=' ';
       printf("\n$%s\t%s$\t%sid",stk,a,act);
       check();
     }
else
        {
       stk[i]=a[j];
       stk[i+1]='\0';
       a[j]=' ';
       printf("\n$%s\t%s$\t%ssymbols",stk,a,act);
       check();
      }
    }
    getch();
  }
 void check()
  {
   strcpy(ac,"REDUCE TO E");
   for(z=0; z<c; z++)
    if(stk[z]=='i' && stk[z+1]=='d')
     {
      stk[z]='E';
      stk[z+1]='\0';
      printf("\n$%s\t%s$\t%s",stk,a,ac);
```

```
       j++;
      }
    for(z=0; z<c; z++)
     if(stk[z]=='E' && stk[z+1]=='+' && stk[z+2]=='E')
      {
       stk[z]='E';
       stk[z+1]='\0';
       stk[z+2]='\0';
       printf("\n$%s\t%s$\t%s",stk,a,ac);
       i=i-2;
      }
    for(z=0; z<c; z++)
     if(stk[z]=='E' && stk[z+1]=='*' && stk[z+2]=='E')
      {
       stk[z]='E';
       stk[z+1]='\0';
       stk[z+1]='\0';
       printf("\n$%s\t%s$\t%s",stk,a,ac);
       i=i-2;
      }
    for(z=0; z<c; z++)
     if(stk[z]=='(' && stk[z+1]=='E' && stk[z+2]==')')
      {
       stk[z]='E';
       stk[z+1]='\0';
stk[z+1]='\0';
          printf("\n$%s\t%s$\t%s",stk,a,ac);
       i=i-2;
      }
  }
```



5. the machine code using code in three-address form:

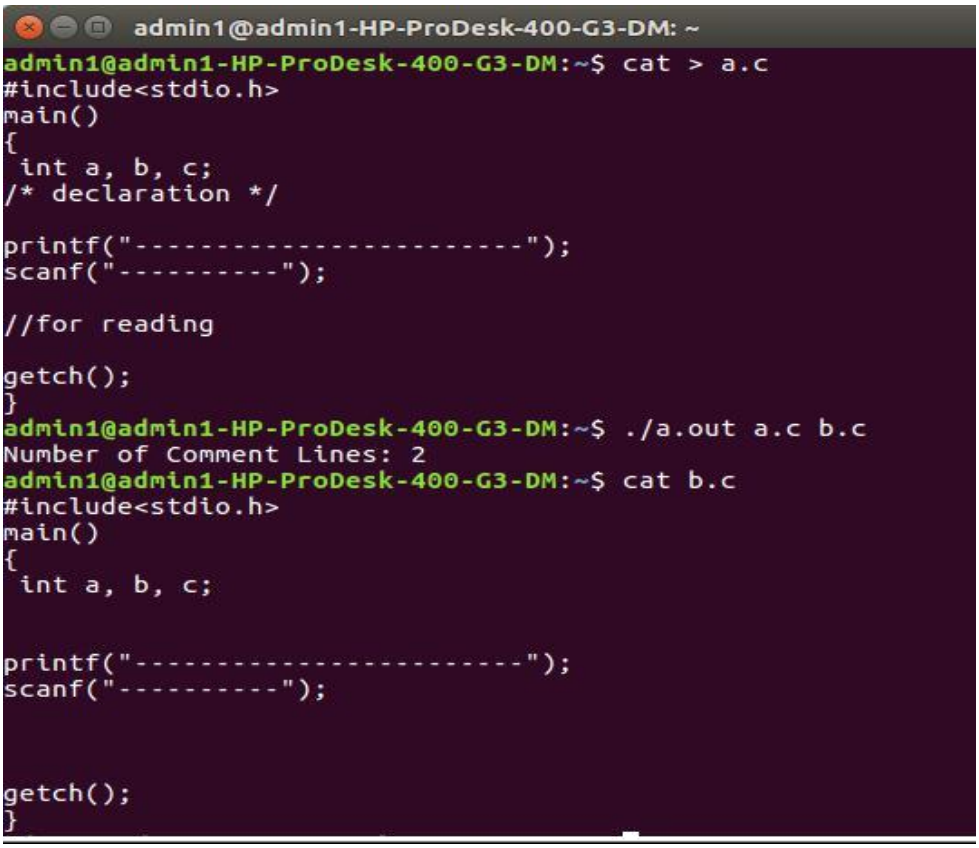
T2 = C + D
T3 = T1 * T2
A = T3

```
#include<stdio.h>
 #include<stdlib.h>
 #include<ctype.h>
#include<string.h>
char tset[4][3][3]= { {"-","B","?"}, {"+","C","D"},
{"*","0","1"}, {"=","A","2"} };
int main()
{
     int row,col;
      for(row=0;row<4;row++)
     {
     col=2;
     if (tset[row][col][0]=='?')
           {
          printf("\nLD R0,%s%s",tset[row][0],tset[row][1]);
          }
          else
           {
          if(tset[row][0][0]=='+')
               {
               printf("\nLD R1,%s",tset[row][1]);
               printf("\nLD R2,%s",tset[row][2]);
               printf("\nADD R1,R1,R2");
               }
          else
                {
               if(tset[row][0][0]=='*')
                {
               printf("\nMUL R1,R1,R0");
               }
                else
                {
                printf("\nST %s,R1",tset[row][1]);
               }
           }
      }
 }
 printf("\n"); return 0;
 }
```


LD R0,-B
LD R1,C
LD R2,D
ADD R1,R1,R2
MUL R1,R1,R0
ST A,R0

6. a) Write a LEX program to eliminate *comment lines* in a *C* program and copy the resulting program into a separate file.

```
%{
#include<stdio.h>
int c_count=0;
%}

%%
"/*"[^*/]*"*/" {c_count++;}
"//".*          {c_count++;}
%%
int main( int argc, char **argv)
{
 FILE *f1,*f2;
if(argc>1)
{
  f1=fopen(argv[1],"r");    /*open first file for reading*/
  if(!f1)                   /*not able to open file*/
{
   printf("file error \n");
     exit(1);
}
yyin=f1;
 f2=fopen(argv[2],"w"); /*open second file for writing*/
 if(!f2)                /*not able to open file*/
 {
printf("Error");
  exit(1);
 }
yyout=f2;

yylex();
printf("Number of Comment Lines: %d\n",c_count);
}
return 0;
}
```


admin1@admin1-HP-ProDesk-400-G3-DM: ~
admin1@admin1-HP-ProDesk-400-G3-DM:~$ cat > a.c
#include<stdio.h>
main()
{
int a, b, c;
/* declaration */
printf("------------------------");
scanf("----------");
//for reading
getch();
}
admin1@admin1-HP-ProDesk-400-G3-DM:~$ ./a.out a.c b.c
Number of Comment Lines: 2
admin1@admin1-HP-ProDesk-400-G3-DM:~$ cat b.c
#include<stdio.h>
main()
{
int a, b, c;
printf("------------------------");
scanf("----------");
getch();
}

b) Write YACC program to recognize valid *identifier, operators* and *keywords* in the given text (C program) file.

Lex File

```
%{
#include <stdio.h>
#include "y.tab.h"
extern yylval;
%}
%%
[ \t] ;
[+|-|*|/|=|<|>] {printf("operator is %s\n",yytext);return OP;}
[0-9]+ {yylval = atoi(yytext); printf("numbers
is %d\n",yylval); return DIGIT;}
int|char|bool|float|void|for|do|while|if|else|return|void
{printf("keyword is
%s\n",yytext);return KEY;}
[a-zA-Z0-9]+ {printf("identifier is %s\n",yytext);return ID;}
. ;
%%
```

Yacc File

```
%{
#include <stdio.h>
#include <stdlib.h>
int id=0, dig=0, key=0, op=0;
%}
%token DIGIT ID KEY OP
%%
input:
DIGIT input { dig++; }
| ID input { id++; }
| KEY input { key++; }
| OP input {op++;}
| DIGIT { dig++; }
| ID { id++; }
| KEY { key++; }
| OP { op++;}
;
%%
#include <stdio.h>
extern int yylex();
extern int yyparse();
extern FILE *yyin;
```

```
main()
 {
FILE *myfile = fopen("sam_input.c", "r");
  if (!myfile) {
  printf("I can't open sam_input.c!");
  return -1;
  }
  yyin = myfile;
  do {
  yyparse();
  } while (!feof(yyin));
  printf("numbers = %d\nKeywords = %d\nIdentifiers
  = %d\noperators = %d\n",
  dig, key,id, op);
  }
  void yyerror() {
  printf("EEK, parse error! Message: ");
  exit(-1);
  }
```

```
1 void main()
2 {
3     float a123;
4     char a;
5     char b123;
6     char c;
7     if (sum == 10)
8         printf("pass");
9     else
10        printf("fail");
11 }
```

```
admin1@admin1-HP-ProDesk-400-G3-DM:~$ ./a.out
keyword is void
identifier is main


keyword is float
identifier is a123

keyword is char
identifier is a

keyword is char
identifier is b123

keyword is char
identifier is c

keyword is if
identifier is sum
operator is =
operator is =
numbers is 10

identifier is printf
identifier is pass

keyword is else

identifier is printf
identifier is fail


numbers = 1
Keywords = 7
Identifiers = 10
operators = 2
admin1@admin1-HP-ProDesk-400-G3-DM:~$
```

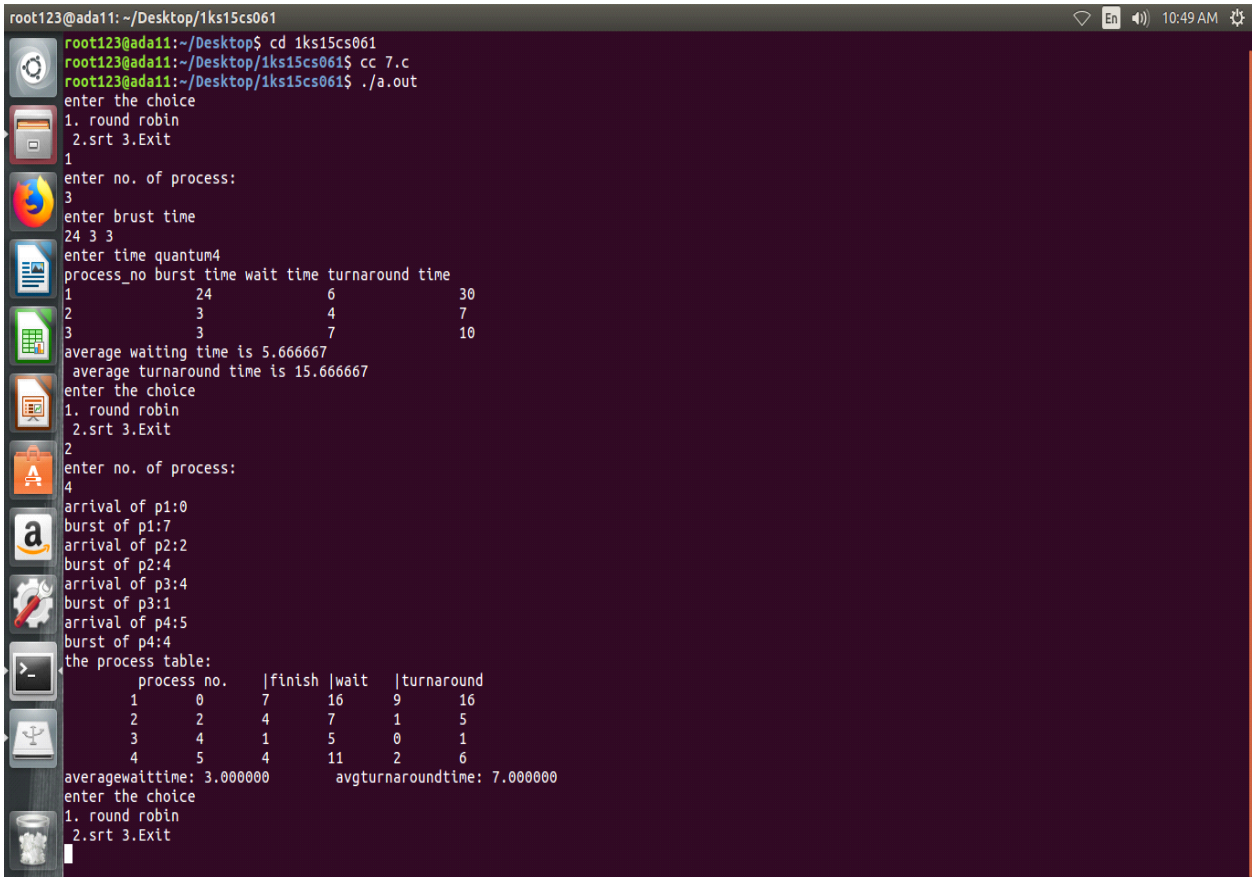
7. Design, develop and implement a C/C++/Java program to simulate the working of ***Shortest remaining time*** and ***Round Robin (RR)*** scheduling algorithms. Experiment with different quantum sizes for RR
algorithm.

```
#include<stdio.h>
#include<stdlib.h>
int arrival[10];
int burst[10];
int rem[10];
int wait[10];
int finish[10];
int turnaround[10];
int flag[10];
void roundrobin(int,int,int[],int[]);
void srtf(int);

int main()
{
int n,tq,choice;
int bt[10],st[10],i,j;
for(;;)
{
printf("enter the choice\n1. round robin\n 2.srt 3.Exit\n");
scanf("%d",&choice);
switch(choice)
{
case 1:
printf("enter no. of process:\n");
scanf("%d",&n);
printf("enter brust time\n");
for(i=0;i<n;i++)
{
  scanf("%d",&bt[i]);
  st[i]=bt[i];
}
printf("enter time quantum");
scanf("%d",&tq);
roundrobin(n,tq,st,bt);
break;

case 2:
printf("enter no. of process:\n");
scanf("%d",&n);
srtf(n);
break;
```

```
case 3:return 0;
}
}
}
void roundrobin(int n,int tq,int st[],int bt[])
{
int time=0;
int tat[10],wt[10],i,count=0,swt=0,stat=0,temp1,sq=0;

while(1)
{
for(i=0,count=0;i<n;i++)
{
temp1=tq;
if(st[i]==0)
{
count++;
continue;
}
if(st[i]>tq)
  st[i]=st[i]-tq;
else
if(st[i]>=0)
{
temp1=st[i];
st[i]=0;
}

sq=sq+temp1;
tat[i]=sq;
}

if(n==count)
break;
}
for(i=0;i<n;i++)
{
wt[i]=tat[i]-bt[i];
swt=swt+wt[i];
stat=stat+tat[i];
}
printf("process_no burst time wait time turnaround time\n");
for(i=0;i<n;i++)
   printf("%d\t\t%d\t\t%d\t\t%d\n",i+1,bt[i],wt[i],tat[i]);
printf("average waiting time is %f\n average turnaround time
is %f\n",(float)swt/n,(float)stat/n);
```

```
}

void srtf(int n)
{
int stat=0,swt=0,time=0,count=0,i,j,min=999;
for(i=1;i<=n;i++)
{
printf("arrival of p%d:",i);
scanf("%d",&arrival[i]);
printf("burst of p%d:",i);
scanf("%d",&burst[i]);
rem[i]=burst[i];
flag[i]=0;
}

while(1)
{

for(i=1,min=999;i<=n;i++)
  if(arrival[i]<=time&&flag[i]==0)
     if(rem[i]<min)
       {
         min=rem[i];
         j=i;
       }
        time++;
        rem[j]-=1;
       if(rem[j]==0)
       {
         finish[j]=time;
         flag[j]=1;
         count++;
       }
       if(count==n)
         break;
}
for(i=1;i<=n;i++)
 {
   turnaround[i]=finish[i]-arrival[i];
   wait[i]=turnaround[i]-burst[i];
   stat+=turnaround[i];
   swt+=wait[i];
 }

printf("the process table:\n\t process
no.\t|finish\t|wait\t|turnaround\t\n");
for(i=1;i<=n;i++)
```

```
   printf("\t%d  \t%d  \t%d  \t%d  \t%d
\t%d\n",i,arrival[i],burst[i],finish[i],wait[i],turnaround[i]);
printf("averagewaittime: %f\t
avgturnaroundtime: %f\n",(float)swt/n,(float)stat/n);
return;
}
```



8. Design, develop and implement a C/C++/Java program to implement ***Banker's algorithm***. Assume suitable input required to demonstrate the results.

```
#include <stdio.h>
#include <stdlib.h>
int main()
{
  int Max[10][10], need[10][10], alloc[10][10],
    avail[10], completed[10], safeSequence[10];
  int p, r, i, j, process, count;
  count = 0;

  printf("Enter the no of processes : ");
  scanf("%d", &p);

  for(i = 0; i< p; i++)
  completed[i] = 0;

  printf("\n\nEnter the no of resources : ");
  scanf("%d", &r);

  printf("\n\nEnter the Max Matrix for each process : ");
  for(i = 0; i < p; i++)
  {
    printf("\nFor process %d : ", i + 1);
    for(j = 0; j < r; j++)
    scanf("%d", &Max[i][j]);
}
 printf("\n\nEnter the allocation for each process : ");
 for(i = 0; i < p; i++)
 {
   printf("\nFor process %d : ",i + 1);
   for(j = 0; j < r; j++)
   scanf("%d", &alloc[i][j]);
 }

 printf("\n\nEnter the Available Resources : );
 for(i = 0; i < r; i++)
  scanf("%d", &avail[i]);

   for(i = 0; i < p; i++)
   for(j = 0; j < r; j++)
   need[i][j] = Max[i][j] - alloc[i][j];
```

```
do
{
  printf("\n Max matrix:\tAllocation matrix:\n");

  for(i = 0; i < p; i++)
  {
      for( j = 0; j < r; j++)
      printf("%d ", Max[i][j]);
      printf("\t\t");
      for( j = 0; j < r; j++)
      printf("%d ", alloc[i][j]);
      printf("\n");
  }

  process = -1;

  for(i = 0; i < p; i++)
  {
    if(completed[i] == 0)//if not completed
    {
      process = i ;
      for(j = 0; j < r; j++)
      {
        if(avail[j] < need[i][j])
        {
          process = -1;
          break;
              }
       }
     }
     if(process != -1)
       break;
   }

   if(process != -1)
   {
     printf("\nProcess %d runs to completion!", process + 1);
     safeSequence[count] = process + 1; count++;
     for(j = 0; j < r; j++)
     {
       avail[j] += alloc[process][j];
       alloc[process][j] = 0;
       Max[process][j] = 0;
       completed[process] = 1;
     }
   }
 }
```

```
    while(count != p && process != -1);

    if(count == p)
    {
      printf("\nThe system is in a safe state!!\n");
      printf("Safe Sequence : < ");
      for( i = 0; i < p; i++)
        printf("%d ", safeSequence[i]);
      printf(">\n");
    }
    else
      printf("\nThe system is in an unsafe state!!");

}
```

Output:

```
Enter the no of processes : 5
Enter the no of resources : 3
Enter the Max Matrix for each process :
For process 1 : 7
5
3
For process 2 : 3
2
2
For process 3 : 7
0
2
For process 4 : 2
2
2
For process 5 : 4
3
3

Enter the allocation for each process :
For process 1 : 0
1
0
For process 2 : 2
0
0
For process 3 : 3
0
2
```

```
For process 4 : 2
1
1
For process 5 : 0
0
2
Enter the Available Resources : 3
3
2
  Max matrix:    Allocation matrix:
7 5 3          0  1 0
3 2 2          2  0 0
7 0 2          3  0 2
2 2 2          2  1 1
4 3 3          0  0 2

Process 2 runs to completion!
  Max matrix:    Allocation matrix:
7 5 3          0  1 0
0 0 0          0  0 0
7 0 2          3  0 2
2 2 2          2  1 1

4 3 3           0 0 2

Process 3 runs to completion!
 Max matrix:      Allocation matrix:
7 5 3          0 1 0
0 0 0          0 0 0
0 0 0          0 0 0
2 2 2          2 1 1
4 3 3          0 0 2

Process 4 runs to completion!
 Max matrix:      Allocation matrix:
7 5 3          0 1 0
0 0 0          0 0 0
0 0 0          0 0 0
0 0 0          0 0 0
4 3 3          0 0 2

Process 1 runs to completion!
 Max matrix:      Allocation matrix:
0 0 0          0 0 0
0 0 0          0 0 0
0 0 0          0 0 0
```

0 0 0 0 0 0
4 3 3 0 0 2

Process 5 runs to completion!
The system is in a safe state!!
Safe Sequence: < 2 3 4 1 5 >

9. Design, develop and implement a C/C++/Java program to implement ***page replacement algorithms LRU*** and ***FIFO***. Assume suitable input required to demonstrate the results.

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

void FIFO()
{
     char s[200];
     char F[200];
     int l,f,i,j=0,k,flag=0,cnt=0;

     printf("\nEnter the number of frames : ");
     scanf("%d",&f);

     printf("\nEnter the length of the string: ");
     scanf("%d",&l);

     printf("\nEnter the string: ");
     scanf("%s", s);

     for(i=0;i<f;i++)
     F[i]=' ';

     printf("\n\tPAGE\t\tFRAMES\t\t\tFAULTS");
     for(i=0;i<l;i++)
     {
               for(k=0;k<f;k++)
               if(F[k]==s[i])
               flag=1;

               if(flag==0)
               {
                    printf("\n\t%c\t",s[i]);
                    F[j]=s[i];
                    j++;
                    for(k=0;k<f;k++)
                    printf("\t%c",F[k]);
                    printf("\tPage-fault%d",cnt);
                    cnt++;
               }
               else
```

```
                {
                        flag=0;
                        printf("\n\t%c\t",s[i]);
                        for(k=0;k<f;k++)
                        printf("\t%c",F[k]);
                        printf("\tNo page-fault");
                }
                if(j==f)
                j=0;
        }
}

int findLRU(int time[], int n)
{
        int i, minimum = time[0], pos = 0;
        for(i = 1; i < n; ++i)
        {
                if(time[i] < minimum)
                {
                        minimum = time[i];
                        pos = i;
                }
        }
        return pos;
}

int lru()
{
        int no_of_frames, no_of_pages, frames[10], counter = 0;
        int time[10], flag1, flag2, i, j, pos, faults = 0, page;
        char s[200];

        printf("\nEnter number of frames: ");
        scanf("%d", &no_of_frames);

        printf("\nEnter number of pages: ");
        scanf("%d", &no_of_pages);

        printf("\nEnter reference string: ");
        scanf("%s", s);

        for(i = 0; i < no_of_frames; ++i)
        frames[i] = -1;
```

```
    for(i = 0; i < no_of_pages; ++i)
    {
        flag1 = flag2 = 0;
        page = s[i] - '0';
        for(j = 0; j < no_of_frames; ++j)
        {
            if(frames[j] == page)
            {
                counter++;
                time[j] = counter;
                flag1 = flag2 = 1;
                break;
            }
        }
        if(flag1 == 0)
        {
            for(j = 0; j < no_of_frames; ++j)
            {
                if(frames[j] == -1)
                {
                    counter++;
                    faults++;
                    frames[j] = page;
                    time[j] = counter;
                    flag2 = 1;
                    break;
                }
            }
        }
        if(flag2 == 0)
        {
            pos = findLRU(time, no_of_frames);
            counter++;
            faults++;
            frames[pos] = page;
            time[pos] = counter;
        }
        printf("\n");
        for(j = 0; j < no_of_frames; ++j)
        printf("%d\t", frames[j]);
    }
    printf("\n\nTotal Page Faults = %d", faults);
    return 0;
}
```

```
int main()
{
     int ch,YN=1,i,l,f;
     char F[10],s[25];
     do
     {
          printf("\nOptions : ");
          printf("\n\n1:FIFO\n2:LRU \n3:EXIT");
          printf("\n\nEnter your choice: ");
          scanf("%d",&ch);
          switch(ch)
          {
               case 1:   FIFO();
                    break;
               case 2: lru();
                    break;
               default:
                    exit(0);
          }
          printf("\n\nPress 1 to continue.. 0 to exit ");
          scanf("%d",&YN);
     }while(YN==1);
     return(0);
}
```

```
root123@root123-Inspiron-N5010:~$ ./a.out

Options :

1:FIFO
2:LRU
3:EXIT

Enter your choice: 1

Enter the number of frames : 4

Enter the length of the string: 13

Enter the string: 2342137543231

        PAGE            FRAMES                  FAULTS
        2               2                               Page-fault0
        3               2       3                       Page-fault1
        4               2       3       4               Page-fault2
        2               2       3       4               No page-fault
        1               2       3       4       1       Page-fault3
        3               2       3       4       1       No page-fault
        7               7       3       4       1       Page-fault4
        5               7       5       4       1       Page-fault5
        4               7       5       4       1       No page-fault
        3               7       5       3       1       Page-fault6
        2               7       5       3       2       Page-fault7
        3               7       5       3       2       No page-fault
        1               1       5       3       2       Page-fault8

Press 1 to continue.. 0 to exit

Options :

1:FIFO
2:LRU
3:EXIT

Enter your choice: 2

Enter number of frames: 4

Enter number of pages: 13

Enter reference string: 2342137543231

2       -1      -1      -1
2       3       -1      -1
2       3       4       -1
2       3       4       -1
2       3       4       1
2       3       4       1
2       3       7       1
5       3       7       1
5       3       7       4
5       3       7       4
5       3       2       4
5       3       2       4
1       3       2       4

Total Page Faults = 9

Press 1 to continue.. 0 to exit
```