J.N.T.U.H UNIVERSITY COLLEGE OF ENGINEERING SCIENCE AND TECHNOLOGY HYDERABAD, KUKATPALLY, HYDERABAD – 500085

CERTIFICATE

This is to certify that **NOOR FATIMA** of CSE(Regular) IV year, I Semester bearing with Hall-Ticket number **22011A0528** has fulfilled her **COMPILER DESIGN LAB** record for the academic year 2025-2026.

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Signature of the HOD ***Signature of the Staff***

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Internal Examiner ***External Examiner***

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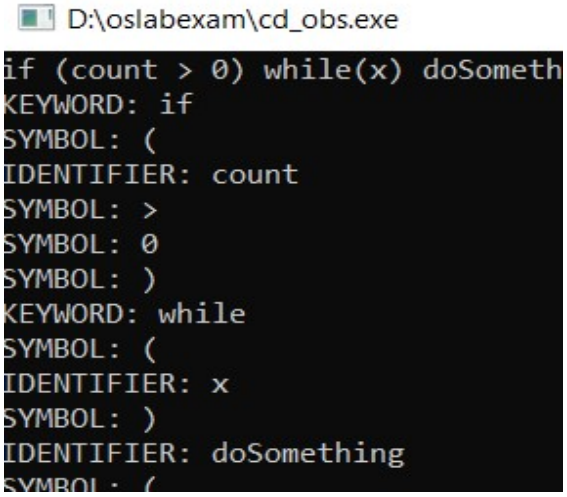
1.Write a C program to design a lexical analyzer that recognizes identifiers and keywords of flow control statements of C language

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

char *keywords[] = {
   "if","else","while","for","do","switch","case",
   "break","continue", NULL
};

int isKeyword(char *s){
for(int i=0; keywords[i]!=NULL; i++)
if(strcmp(s, keywords[i]) == 0)
          return 1;
   return 0;
}

int main(){
  int c;
  char buf[100];
  int i;

while((c = getchar()) != EOF){

       if(isspace(c))
          continue;

if(isalpha(c)){         // identifier or keyword
i = 0;
buf[i++] = c;
while(isalnum(c = getchar()))
buf[i++] = c;
buf[i] = '\0';
ungetc(c, stdin);

          if(isKeyword(buf))
printf("KEYWORD: %s\n", buf);
          else
printf("IDENTIFIER: %s\n", buf);
       }
else{
printf("SYMBOL: %c\n", c);
       }
   }
   return 0;
}
```

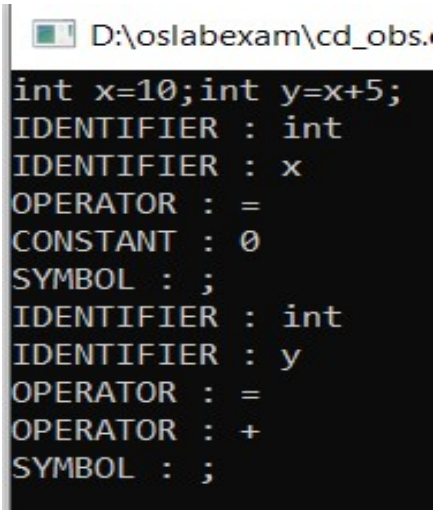


2) Write a C program to design a lexical analyzer that recognizes identifiers,constants,comments,operators etc

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

void printToken(char *type, char *value){
printf("%s : %s\n", type, value);
}

int main(){
   int c;
char buf[100];
int i;

while((c = getchar()) != EOF){
      if(isspace(c))
         continue;
if(isalpha(c)){
i = 0;
buf[i++] = c;
while(isalnum(c = getchar()))
buf[i++] = c;
buf[i] = '\0';
ungetc(c, stdin);

printToken("IDENTIFIER", buf);
         continue;
      }
if(isdigit(c)){
i = 0;
```

```
buf[i++] = c;
while(isdigit(c = getchar()))
buf[i++] = c;
buf[i] = '\0';
ungetc(c, stdin);

printToken("CONSTANT", buf);
            continue;
        }
if(c == '/'){
int d = getchar();

            /* Single-line comment // */
if(d == '/'){
while((c = getchar()) != '\n' && c != EOF);
printToken("COMMENT", "single-line");
            }
else if(d == '*'){
int prev = 0;
while((c = getchar()) != EOF){
if(prev == '*' && c == '/') break;
prev = c;
                }
printToken("COMMENT", "multi-line");
            }
            else {
ungetc(d, stdin);
printf("OPERATOR : /\n");
            }
            continue;
        }
int d = getchar();
if(c=='+' || c=='-' || c=='*' || c=='=' || c=='<' || c=='>' ){
printf("OPERATOR : %c\n", c);
             continue;
       }
else{
ungetc(d, stdin);
        }
printf("SYMBOL : %c\n", c);
    }

    return 0;
```

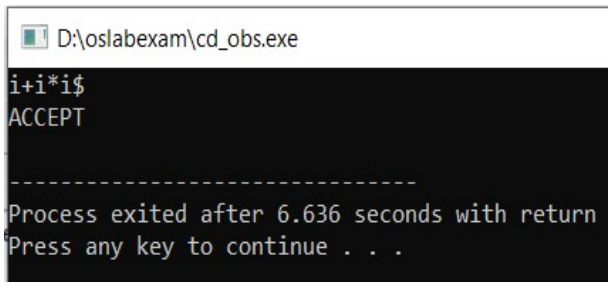
}



3. Write a C program to construct predictive parser for the following grammar
E → T R
R → + T R | ε
T → F P
P → * F P | ε
F → i | (E)

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

char st[50];
int top=-1;

void push(char c){ st[++top]=c; }
void pop(){ top--; }

int main(){
char in[50];
scanf("%s", in);
   int p=0;
push('$'); push('E');

while(top>=0){
      char X = st[top];
      char a = in[p];

      if(X==a){ pop(); p++; if(a=='$'){ printf("ACCEPT\n"); return 0;} }

else if(X=='E'){ pop(); push('R'); push('T'); }
else if(X=='R'){
if(a=='+'){ pop(); push('R'); push('T'); push('+'); }
else pop();  // epsilon
```

```
        }
else if(X=='T'){ pop(); push('P'); push('F'); }
else if(X=='P'){
if(a=='*'){ pop(); push('P'); push('F'); push('*'); }
else pop(); // epsilon
        }
else if(X=='F'){
pop();
            if(a=='i') push('i');
else if(a=='('){ push(')'); push('E'); push('('); }
else { printf("ERROR\n"); return 0; }
        }
else{printf("ERROR\n"); return 0; }
    }
}
```



4.Write a C program to construct Recursive Descent parser for the following grammar

E→TR

R→+TR/∈

T→FP

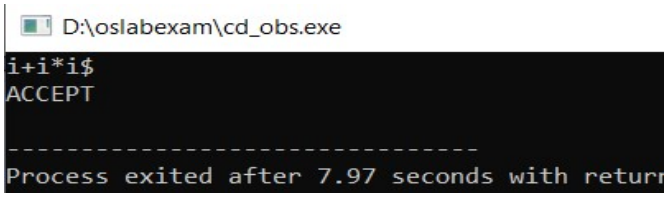
T→*FP/∈

F→a/(E)

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

char in[100];
int p = 0;

char peek(){ return in[p]; }
void advance(){ p++; }
void error(){ printf("ERROR\n"); exit(0); }

void E();
void Ep();
void T();
voidTp();
void F();
```

```
void F(){
if(peek() == 'i'){     // id
advance();
   }
else if(peek() == '('){
advance();
E();
if(peek() == ')') advance();
else error();
   }
else error();
}

voidTp(){
if(peek() == '*'){
advance();
F();
Tp();
   }
   // else epsilon
}

void T(){
F();
Tp();
}

void Ep(){
if(peek() == '+'){
advance();
T();
Ep();
   }
   // else epsilon
}

void E(){
T();
Ep();
}

int main(){
scanf("%s", in);

E();
```

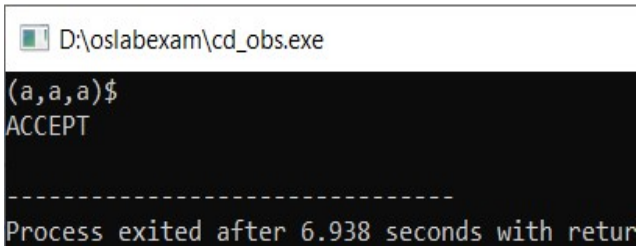
```
if(peek()=='$')
printf("ACCEPT\n");
   else
printf("ERROR\n");
}
```



5. write recursive descent parser for the grammar S->(L) S->a L->L,S L->S

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

char in[100];
int p = 0;

char peek(){ return in[p]; }
void advance(){ p++; }
void error(){ printf("ERROR\n"); exit(0); }

void S();
void L();
voidLp();

void S(){
if(peek()=='a'){
advance();
   }
else if(peek()=='('){
advance();
L();
if(peek()==')') advance();
else error();
   }
else error();
}

voidLp(){
if(peek()==','){
advance();
S();
Lp();
   }
   // else epsilon
```

```
}

void L(){
S();
Lp();
}

int main(){
scanf("%s", in);

S();

if(peek()=='$')
printf("ACCEPT\n");
   else
printf("ERROR\n");

   return 0;
}
```



6.Write a Lex specification to recognize +veintegers,reals and -veintegers,reals.

```
%{
#include <stdio.h>
%}
%%
\+?[0-9]+              { printf("%s:positive integers\n", yytext); }
-[0-9]+               { printf("%s:negative integers\n", yytext); }
-[0-9]+\.[0-9]+         { printf("%s:negative real numbers\n", yytext); }
\+?[0-9]+\.[0-9]+       { printf("%s:positive real numbers\n", yytext); }
%%
int main()
{
yylex();
   return 0;
}
```

Compilation: lexnoformat.l

cc lex.yy.c -ll

./a.out

24

positive integer

+24.12
positive real number
-24
negative integer
-24.12
negative real number

7.Write a Lex specification for converting real numbers to integers.

```
%{
int i, j;
#include <stdio.h>
#include <stdlib.h>
%}
%%
[0-9]*\.[0-9]+  {
                for (i = 0; i<yyleng; i++)
                {
                    if (yytext[i] == '.')
                    {
                        for (j = 0; j <= i - 1; j++)
printf("%c", yytext[j]);
                        break;
                    }
                }
exit(0);
            }
%%
int main(void)
{
yylex();
   return 0;
}
```

Compilation: lexrealtoint.l

cc lex.yy.c -ll

./a.out

24.12

24

8.Write a Lex specification to print the number of days in a month using a procedure

```
%{
#include <stdio.h>
int year;
void leap(void);        /* prototype */
%}
```

```
%%

jan|mar|may|july|aug|oct|dec{ printf("31 days"); }
april|june|sep|nov{ printf("30 days"); }
feb                    { leap(); }
[a-zA-Z]*                { printf("invalid"); }

%%

main()
{
yylex();
}

void leap(void)
{
printf("enter year");
scanf("%d", &year);
   if (year % 4 == 0)
printf("29 days");
   else
printf("28 days");
}
```

Compilation: lexdaysinamonth.l

```
cc lex.yy.c -ll
./a.out
jan
31 days
june
30 days
feb
enter year
1984
29 days
```

9. Write a Lex specification to retrieve comments.

```
%{

#include<stdio.h>

%}

%%

[/][/][a-z A-Z 0-9]*    {printf("%s",yytext);}

[a-z A-Z 0-9]*          {printf(" ");}

[/][*][a-z A-Z 0-9]*[*][/] {printf("%s",yytext);}
```

```
%%

main()

{

 yylex();

}
```

Compilation: lexcomments.l

```
cc lex.yy.c -ll
./a.out
Hello //world
world
hai /*friend*/
friend
```

10. Write a Lex specification to design a lexical analyzer that recognizes identifiers and keywords of flow control statements of C language

```
%{
        #include<stdio.h>
%}
%%
If|else|while|do|switch|case|break|for|default {printf("Keyword");}
IF|ELSE|WHILE|DO|SWITCH|CASE|BREAK|FOR|DEFAULT          {printf("Keyword");}
[A-Z a-z]+[a-z A-Z 0-9 _]*       {printf("identifier");}
%%
int main()
{
yylex();
return 0;
}
```

Compilation: lexlexanalysis.l

```
cc lex.yy.c -ll
./a.out
If
Keyword
FOR
Keyword
Abc123_def
identifier
```

11. Implement any one storage allocation strategies (heap, stack, static)

Static

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

```
void incrementCounter() {
static int counter = 0;
counter++;
printf("Static counter value = %d  (addr: %p)\n", counter, (void *)&counter);
}

int main(void) {

printf("Calling incrementCounter() first time...\n");
incrementCounter();

printf("\nCallingincrementCounter() second time...\n");
incrementCounter();

printf("\nCallingincrementCounter() third time...\n");
incrementCounter();

printf("\nProgram finished.\n");

return 0;
}
```

```
Calling incrementCounter() first time...
Static counter value = 1  (addr: 0x404024)

Calling incrementCounter() second time...
Static counter value = 2  (addr: 0x404024)

Calling incrementCounter() third time...
Static counter value = 3  (addr: 0x404024)

Program finished.
```

Stack

```
#include <stdio.h>
voidprintValue() {
int x = 10;   // STACK STORAGE (automatic variable)
              // lives only inside this function
printf("Value of x = %d  (addr: %p)\n", x, (void *)&x);
}

int main(void) {

printf("Calling printValue() first time...\n");
printValue();

printf("\nCallingprintValue() second time...\n");
printValue();
```

```
printf("\nCallingprintValue() third time...\n");
printValue();

printf("\nProgram finished.\n");

return 0;
}
```

```
Calling printValue() first time...
Value of x = 10  (addr: 0x7fff6c6e262c)

Calling printValue() second time...
Value of x = 10  (addr: 0x7fff6c6e262c)

Calling printValue() third time...
Value of x = 10  (addr: 0x7fff6c6e262c)

Program finished.
```

Heap

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

int main(void) {
intinitial_size = 3;
intnew_size = 5;

printf("Requesting %d integers on the heap...\n", initial_size);

int *arr = (int *)malloc(initial_size * sizeof(int));
if (arr == NULL) {
perror("malloc failed");
return 1;
   }

   // Fill with values and print addresses
for (inti = 0; i<initial_size; ++i) {
arr[i] = (i + 1) * 10;
printf("arr[%d] = %d  (addr: %p)\n", i, arr[i], (void *)&arr[i]);
   }

printf("\nNow expanding the array to %d integers using realloc...\n", new_size);

int *tmp = (int *)realloc(arr, new_size * sizeof(int));
if (tmp == NULL) {
       // realloc failed: original block (arr) is still valid, must free it
perror("realloc failed");
free(arr);
return 1;
   }
```

```
arr = tmp; // use the (possibly moved) block

    // Initialize new elements
for (inti = initial_size; i<new_size; ++i) {
arr[i] = (i + 1) * 10;
    }

    // Print all elements and addresses again
for (inti = 0; i<new_size; ++i) {
printf("arr[%d] = %d  (addr: %p)\n", i, arr[i], (void *)&arr[i]);
    }

    // Done: free heap memory
free(arr);
printf("\nMemory freed. Program finished.\n");
return 0;
}
```

```
Requesting 3 integers on the heap...
arr[0] = 10  (addr: 0x1c1986b0)
arr[1] = 20  (addr: 0x1c1986b4)
arr[2] = 30  (addr: 0x1c1986b8)

Now expanding the array to 5 integers using realloc...
arr[0] = 10  (addr: 0x1c1986b0)
arr[1] = 20  (addr: 0x1c1986b4)
arr[2] = 30  (addr: 0x1c1986b8)
arr[3] = 40  (addr: 0x1c1986bc)
arr[4] = 50  (addr: 0x1c1986c0)

Memory freed. Program finished.
```

12. Implementation of symbol table.

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

#define MAX 50

struct Symbol {
    char name[20];
    char type[20];
} table[MAX];

int count = 0;

// Insert
void insert(char name[], char type[]) {
    strcpy(table[count].name, name);
    strcpy(table[count].type, type);
    count++;
```

```
}

// Search
int search(char name[]) {
    for (int i = 0; i < count; i++) {
        if (strcmp(table[i].name, name) == 0)
            return i;
    }
    return -1;
}

// Display
void display() {
    printf("\n--- Symbol Table ---\n");
    printf("Name\tType\n");
    for (int i = 0; i < count; i++) {
        printf("%s\t%s\n", table[i].name, table[i].type);
    }
}

int main() {
    int choice;
    char name[20], type[20];

    while (1) {
        printf("\n1. Insert\n2. Search\n3. Display\n4. Exit\n");
        printf("Enter choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter name: ");
                scanf("%s", name);
                printf("Enter type: ");
                scanf("%s", type);
                insert(name, type);
                break;

            case 2:
                printf("Enter name to search: ");
                scanf("%s", name);
                int pos;
                pos = search(name);
                if (pos != -1)
                    printf("Found at index %d\n", pos);
                else
                    printf("Not found\n");
```

```
            break;

        case 3:
            display();
            break;

        case 4:
            return 0;

        default:
            printf("Invalid choice\n");
      }
   }
}
```

13) Implementation of lexical analyzer using lex tool.

```
%{
#include <stdio.h>
%}

%%
[0-9]+          { printf("NUMBER : %s\n", yytext); }
[a-zA-Z_][a-zA-Z0-9_]*   { printf("IDENTIFIER : %s\n", yytext); }
[+\-*/=]        { printf("OPERATOR : %s\n", yytext); }
[ \t\n]+        ;   /* ignore whitespace */
.               { printf("UNKNOWN : %s\n", yytext); }
%%

int yywrap() { return 1; }

int main() {
   yylex();
   return 0;
}
```

14) Implement type checking

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

struct Symbol {
   char name[20];
   char type[10];
} table[10];

int count = 0;
```

```
// Add variable with type
void add(char name[], char type[]) {
    strcpy(table[count].name, name);
    strcpy(table[count].type, type);
    count++;
}

// Get type of variable (stores result in outputType)
void getType(char name[], char outputType[]) {
    for (int i = 0; i < count; i++) {
        if (strcmp(table[i].name, name) == 0) {
            strcpy(outputType, table[i].type);
            return;
        }
    }
    strcpy(outputType, "undef");   // if not found
}

// Type checking
void typeCheck(char var[], char expr[]) {
    char varType[10], exprType[10];

    getType(var, varType);
    getType(expr, exprType);

    if (strcmp(varType, "undef") == 0 || strcmp(exprType, "undef") == 0) {
        printf("Error: Undefined variable\n");
        return;
    }

    if (strcmp(varType, exprType) == 0)
        printf("VALID: %s = %s\n", var, expr);
    else
        printf("TYPE ERROR: %s (%s) cannot take %s (%s)\n",
               var, varType, expr, exprType);
}

int main() {
    add("x", "int");
    add("y", "float");
    add("z", "int");

    typeCheck("x", "z");   // OK
    typeCheck("x", "y");   // Error

    return 0;
}
```

15) Write a lex program to count the number of words and number of lines in a given file or program.

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

int words = 0;
int lines = 0;
%}

%%
\n              { lines++; }          /* count lines */
[ \t]+          ;                     /* ignore spaces, tabs */
[A-Za-z0-9_]+   { words++; }          /* count words */
.               ;                     /* ignore other characters */
%%

int yywrap() { return 1; }

int main() {
    yylex();
    printf("Lines = %d\nWords = %d\n", lines, words);
    return 0;
}
```

16) Write a C program to calculate first function for the grammar E->E+T E->T T->T*F T->F F->(E)/id

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

char prod[20][20];     // productions
char first[20][20];    // FIRST sets
char nt[20];           // non-terminals list
int n, ntCount = 0;    // number of productions, number of NTs
int done[256] = {0};   // memoization flag

int findNT(char c) {
    for (int i = 0; i < ntCount; i++)
        if (nt[i] == c)
            return i;
    nt[ntCount] = c;
    first[ntCount][0] = '\0';
    return ntCount++;
}
```

```
void add(char set[], char c) {
    if (!strchr(set, c)) {
        int l = strlen(set);
        set[l] = c;
        set[l+1] = '\0';
    }
}

// Compute FIRST for non-terminal X
void computeFIRST(char X) {
    int idx = findNT(X);
    if (done[X]) return;   // avoid infinite recursion on left-recursion
    done[X] = 1;

    for (int i = 0; i < n; i++) {
        if (prod[i][0] == X) {
            char *rhs = strchr(prod[i], '>') + 1;

            // Case 1: RHS starts with terminal or symbol like '(' '+'
            if (!isupper(rhs[0]) && rhs[0] != '#') {
                add(first[idx], rhs[0]);
            }
            // Case 2: RHS starts with epsilon
            else if (rhs[0] == '#') {
                add(first[idx], '#');
            }
            // Case 3: RHS starts with non-terminal
            else if (isupper(rhs[0])) {
                computeFIRST(rhs[0]);
                int j = findNT(rhs[0]);
                for (int k = 0; k < strlen(first[j]); k++)
                    add(first[idx], first[j][k]);
            }
        }
    }
}

int main() {
    printf("Enter number of productions: ");
    scanf("%d", &n);

    printf("Enter productions like E->E+T (use # for epsilon):\n");

    for (int i = 0; i < n; i++) {
        scanf("%s", prod[i]);
        findNT(prod[i][0]);     // record non-terminal
    }
```

```
    // Compute FIRST for all non-terminals
    for (int i = 0; i < ntCount; i++)
        computeFIRST(nt[i]);

    printf("\nFIRST sets:\n");
    for (int i = 0; i < ntCount; i++)
        printf("FIRST(%c) = { %s }\n", nt[i], first[i]);

    return 0;
}
```