

MODEL ENGINEERING COLLEGE, THRIKKAKARA

DEPARTMENT OF COMPUTER ENGINEERING
B.TECH IN COMPUTER SCIENCE AND ENGINEERING



LAB MANUAL

CSL411 COMPILER LAB



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

INDEX

SL.NO	CONTENT	PAGE NO.
1	INSTITUTION VISION AND MISSION	3
2	DEPARTMENT MISSION	3
3	PROGRAM OUTCOMES	4
4	PROGRAM SPECIFIC OUTCOMES	6
5	PROGRAM EDUCATIONAL OBJECTIVES	7
6	LAB RULES	8
7	INSTRUCTIONS FOR MAINTAINING THE LAB RECORD	9
8	SYLLABUS	11
9	PRACTICE QUESTIONS	13
10	COURSE OUTCOMES	15
11	CO-PO MAPPING	16
12	CO-PSO MAPPING	17
13	EXPERIMENTS- CO MAPPING	18
14	EVALUATION METHODS	20
15	SAMPLE PROGRAMS	24



Govt.Model Engineering College,Thrikkakara


Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

	Vision	Mission
INSTITUTION (Model Engg. College)	Evolve into an academy of excellence to serve the knowledge society.	<p>M1: Implement quality education through Teaching Learning Process.</p> <p>M2: Inculcate culture of technical innovations and creativity.</p> <p>M3: Instill high standards of professional ethics and social values.</p>
DEPARTMENT (Computer Engineering)	Evolve into a center of excellence to serve the emerging knowledge society.	<p>M1: Impart quality education to the graduate and undergraduate students in Computer Science and Engineering.</p> <p>M2: Inculcate students with technical knowledge and human values to create socially committed Engineers.</p> <p>M3: Empower the students to succeed in innovative research and developments to serve the computational needs of the society.</p>

	<p align="center"> Govt.Model Engineering College,Thrikkakara Managed by Institute of Human Resources Development A Govt.of Kerala Establishment Department of Computer Engineering B.Tech in Computer Science and Engineering </p>
---	--

PROGRAM OUTCOMES

PO1:Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2: Problem analysis	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3:Design/development of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4:Conduct investigations of complex problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5: Modern tool usage	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

PO 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.
PO 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.
PO 8: Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9: Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 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.



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

PO11:Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12: Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES

PSO1: Hardware & Software	An ability to analyze, design, and develop system software, secure application software, intelligent systems, computer architecture, and network-based computing solutions.
PSO2:Problem Solving	An ability to analyze & design algorithms, and implement the solutions incorporating various programming concepts.
PSO3:Project Management	An ability to apply diverse software project development approaches to tackle real time problems.



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

PROGRAM EDUCATIONAL OBJECTIVES

PEO1:Lifelong Learning	To produce graduates with solid foundation in Computer Science & Engineering and broad knowledge in mathematics, applied science and basic engineering with competence for higher studies and to pursue a profession in computing.
PEO2:Entrepreneurs hip	To impart an educational foundation that enables them to be good entrepreneurs and be adaptive to the advancements in the latest technologies.
PEO3:Social Commitment & Leadership	To make them capable to function in multi-disciplinary teams, ethically and responsibly, contributing to the information technology requirements of the society.



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

LAB RULES

- 1. BE PUNCTUAL FOR THE LAB.**
- 2. STUDENTS SHOULD LEAVE THEIR FOOTWEAR OUTSIDE THE LAB IN THE SPACE PROVIDED.**
- 3. KEEP YOUR BELONGINGS OUTSIDE THE LAB.**
- 4. RECORD ENTRY AND EXIT TIME IN THE LOG-REGISTER WHILE USING THE LAB.**
- 5. COME WELL PREPARED WITH RECORD FOR DOING THE EXPERIMENT.**
- 6. AVOID STEPPING ON ELECTRICAL WIRES OR COMPUTER CABLES.**
- 7. DO NOT SHIFT OR INTERCHANGE ANY PART OF THE COMPUTER WITH ANOTHER.**
- 8. FOR ANY HARDWARE PROBLEM, REPORT TO THE LAB-IN-CHARGE / LAB STAFF.**



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

- 9. STUDENTS SHOULD MAINTAIN SILENCE AND DECORUM
IN THE LAB.**
- 10. STUDENTS SHOULD LOG OFF THE COMPUTERS AND
ARRANGE THEIR SEATS BEFORE LEAVING THE
LABORATORY.**
- 11. VIOLATION OF LAB RULES WILL NECESSITATES IN THE
LOSS OF YOUR LAB PRIVILEGES**



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development


A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

INSTRUCTIONS FOR MAINTAINING THE LAB RECORD

1. The index page should be filled properly by writing the corresponding experiment number, name and date on which the experiment was performed.
2. Every experiment conducted in the lab should be noted in the fair record.
3. For every experiment in the fair record the right-hand page should contain
 - **Title:** The experiment heading on top of the page in capital letters with experiment number and date of experiment.
 - **Aim:** The aim of experiment in one or two sentences clearly.
 - **Algorithm:** Steps for doing the experiment.
 - **Result:** The result of the experiment must be summarized.
4. The left-hand page should contain
 - A **print out of the code** used for the experiment
 - **Sample output** obtained for a set of input.

	<p align="center"> Govt.Model Engineering College,Thrikkakara Managed by Institute of Human Resources Development A Govt.of Kerala Establishment Department of Computer Engineering B.Tech in Computer Science and Engineering </p>
---	--

Course code	Course name	L-T-P	Year of Introduction
CSL411	COMPILER LAB	0-0-3-2	2019

Pre-requisite : CSL331 System Software Lab,CST 301 Formal languages and Automata Theory, CST 302 Compiler Design

SYLLABUS

1. Implementation of lexical analyzer using the tool LEX.
2. Implementation of Syntax analyzer using the tool YACC.
3. Application problems using NFA and DFA.
4. Implement Top-Down Parser.
5. Implement Bottom-up parser.
6. Simulation of code optimization Techniques.
7. Implement Intermediate code generation for simple expressions.
8. Implement the back end of the compiler.



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

Course Objectives:

To implement the different Phases of the compiler.


To implement and test simple optimization techniques.

To give exposure to compiler writing tools.

Expected Outcome:

The Student will be able to :

- i. Implement the techniques of Lexical Analysis and Syntax Analysis.
- ii. Apply the knowledge of Lex & Yacc tools to develop programs.
- iii. Generate intermediate code.
- iv. Implement Optimization techniques and generate machine level code.

	<p align="center"> Govt.Model Engineering College,Thrikkakara Managed by Institute of Human Resources Development A Govt.of Kerala Establishment Department of Computer Engineering B.Tech in Computer Science and Engineering </p>
---	--

PRACTICE QUESTIONS

List of Exercises/Experiments :

1. Design and implement a lexical analyzer using C language to recognize all valid tokens in the input program. The lexical analyzer should ignore redundant spaces, tabs and newlines. It should also ignore comments.
2. Implement a Lexical Analyzer for a given program using Lex Tool.
3. Write a lex program to display the number of lines, words and characters in an input text.
4. Write a LEX Program to convert the substring abc to ABC from the given input string.
5. Write a lex program to find out the total number of vowels and consonants from the given input string.
6. Generate a YACC specification to recognize a valid arithmetic expression that uses operators +, − , *, / and parenthesis. COMPUTER SCIENCE AND ENGINEERING
7. Generate a YACC specification to recognize a valid identifier which starts with a letter followed by any number of letters or digits.
8. Implementation of Calculator using LEX and YACC
9. Convert the BNF rules into YACC form and write code to generate abstract syntax tree.



Govt. Model Engineering College, Thrikkakara


Managed by Institute of Human Resources Development

A Govt. of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

10. Write a program to find ϵ – closure of all states of any given NFA with ϵ transition.
11. Write a program to convert NFA with ϵ transition to NFA without ϵ transition.
12. Write a program to convert NFA to DFA.
13. Write a program to minimize any given DFA.
14. Write a program to find First and Follow of any given grammar.
15. Design and implement a recursive descent parser for a given grammar.
16. Construct a Shift Reduce Parser for a given language.
17. Write a program to perform constant propagation.
18. Implement Intermediate code generation for simple expressions.
19. Implement the back end of the compiler which takes the three address code and produces the 8086 assembly language instructions that can be assembled and run using an 8086 assembler. The target assembly instructions can be simple move, add, sub, jump etc.

	<p align="center"> Govt.Model Engineering College,Thrikkakara Managed by Institute of Human Resources Development A Govt.of Kerala Establishment Department of Computer Engineering B.Tech in Computer Science and Engineering </p>
---	--

CSL411 COMPILER LAB COURSE OUTCOMES

CSL411.1	Implement lexical analyzer using the tool LEX. (Cognitive Knowledge Level: Apply)
CSL411.2	Implement Syntax analyzer using the tool YACC. (Cognitive Knowledge Level: Apply)
CSL411.3	Design NFA and DFA for a problem and write programs to perform operations on it. (Cognitive Knowledge Level: Apply)
CSL411.4	Design and Implement Top-Down parsers. (Cognitive Knowledge Level: Apply)
CSL411.5	Design and Implement Bottom-Up parsers. (Cognitive Knowledge Level: Apply)
CSL411.6	Develop intermediate code for simple expressions. (Cognitive Knowledge Level: Apply)



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

CO-PO MAPPING

Course outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CSL411.1	3	3	2	2	0			0		0		2
CSL411.2	3	3	2	3	0			0		0		2
CSL411.3	3	3	3	3				0		0		2
CSL411.4	3	3	3	3				0		0		2
CSL411.5	3	3	2	2				0		0		2
CSL411.6	3	3	3	3				0		0		2



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

CO-PSO MAPPING

Course outcomes	PSO 1	PSO 2	PSO 3
CSL411.1	3	3	
CSL411.2	3	3	
CSL411.3	3	3	
CSL411.4	3	3	
CSL411.5	3	3	
CSL411.6	3	3	



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

List of Experiments-CO Mapping

1. Design and implement a lexical analyzer using C language to recognize all valid tokens in the input program. The lexical analyzer should ignore redundant spaces, tabs and newlines. It should also ignore comments.
2. Implement a Lexical Analyzer for a given program using Lex Tool.
3. Write a lex program to display the number of lines, words and characters in an input text.
4. Write a LEX Program to convert the substring abc to ABC from the given input string.
5. Write a lex program to find out the total number of vowels and consonants from the given input string.
6. Generate a YACC specification to recognize a valid arithmetic expression that uses operators +, - , *, / and parenthesis. COMPUTER SCIENCE AND ENGINEERING
7. Generate a YACC specification to recognize a valid identifier which starts with a letter followed by any number of letters or digits.
8. Implementation of Calculator using LEX and YACC
9. Convert the BNF rules into YACC form and write code to generate abstract syntax tree.
10. Write a program to find ϵ – closure of all states of any given NFA with ϵ transition.



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment


Department of Computer Engineering

B.Tech in Computer Science and Engineering

11. Write a program to convert NFA with ϵ transition to NFA without ϵ transition.
12. Write a program to convert NFA to DFA.
13. Write a program to minimize any given DFA.
14. Write a program to find First and Follow of any given grammar.
15. Design and implement a recursive descent parser for a given grammar.
16. Construct a Shift Reduce Parser for a given language.
17. Write a program to perform constant propagation.
18. Implement Intermediate code generation for simple expressions.
19. Implement the back end of the compiler which takes the three address code and produces the 8086 assembly language instructions that can be assembled and run using an 8086 assembler. The target assembly instructions can be simple move, add, sub, jump etc.

Reference Books:

1. Aho A Ravi Sethi and J D Ullman, Compilers Principles Techniques and Tools, Addison Wesley
2. Kenneth C Loudon, "Compiler Construction Principles and Practice", Cenage Learning Indian Edition
3. D M Dhamdhare, System programming and operating system, Tata McGraw Hill & Company
4. Tremblay and Sorenson, The Theory and Practice of Compiler Writing - Tata

	<p align="center"> Govt.Model Engineering College,Thrikkakara Managed by Institute of Human Resources Development A Govt.of Kerala Establishment Department of Computer Engineering B.Tech in Computer Science and Engineering </p>
---	--

McGraw Hill & Company
Evaluation Methods For Laboratory Experiments:

Assessment Methods	Continuous Evaluation	Internal
Rubrics	R1	R2 R3 R4 R5
Marks	15	10 5 15 15
Total	60	

Criteria	Parameters evaluated	Performance indicators		
		Beginning(1)	Satisfactory(2)	Exemplary(3)



Govt. Model Engineering College, Thrikkakara

Managed by Institute of Human Resources Development

A Govt. of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

Algorithm And Program(R1)	<ul style="list-style-type: none"> • Clarity of the problem • Neatness and completeness in the algorithm and program 	<p>Lack of clarity Of the problem.</p> <p>Algorithm and program are not accurate.</p>	<p>Demonstrates fair understanding of the concepts and problem.</p> <p>Algorithm and program needs minor correction.</p>	<p>Demonstrates appropriate understanding of the concepts and problem.</p> <p>The algorithm and the program are accurate and neat.</p>
Viva(R2)	<ul style="list-style-type: none"> • Knowledge of concepts and procedure. • Pre-requisite knowledge needed for implementing the problem. 	<p>Unable to articulate the concepts and does not answer most of the questions.</p>	<p>Articulates fairly well and answers most of the questions correctly.</p>	<p>Good command over the concepts associated with the problem and answers all questions.</p>



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

Record(R3)	<ul style="list-style-type: none"> ● Promptness in submission. ● Neat documentation. ● Accurate output 	Incomplete /Late submission of the record.	Late submission. Record documentation is fair.	Record submission on time. Record documentation is complete and neat with perfect outputs.
------------	---	--	---	---



Govt. Model Engineering College, Thrikkakara

Managed by Institute of Human Resources Development

A Govt. of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

Time utilization and completion(R4)	<ul style="list-style-type: none"> Follow the instructions given to complete the lab Completion of the lab in allotted time. 	<p>Unable to follow the verbal and written instructions to complete the lab.</p> <p>Failed to complete even a part of the lab in allotted time.</p>	<p>Unable to follow some of the verbal and written instructions to complete the requirements of the lab</p> <p>The student failed to complete the entire lab in the allotted amount of time</p>	<p>Able to follow the verbal and written instructions to successfully complete requirements of the lab.</p> <p>The student completed the lab in its entirety in the allotted amount of time</p>
Continuous assessment Test (R5)	<p>The assessment test shall be conducted for 100 marks, which will be converted to out of 15. The marks will be distributed as, Algorithm - 30 marks, Program - 20 marks, Output – 20 marks and Viva - 30 marks.</p>			



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

SAMPLE PROGRAMS

1. Design and implement a lexical analyzer for given language using C and the lexical analyzer should ignore redundant spaces, tabs and newlines.

Program

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

int isKeyword(char buffer[]){
    char                keywords[32][10]
    {"auto","break","case","char","const","continue","default",
    "do","double","else","enum","extern","float","for","goto",
    "if","int","long","register","return","short","signed",
    "sizeof","static","struct","switch","typedef","union",
    "unsigned","void","volatile","while"};

    int i;
    for(i = 0; i < 32; ++i){
        if(strcmp(keywords[i], buffer) == 0){
            return 1;
        }
    }
}
```




Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
return 0;  
}
```

```
int main() {  
    char c, buffer[31], operators[] = "+-*/%=";  
    FILE *fp;  
    int i, j=0;
```

```
    fp = fopen("Program","r");
```

```
    if(fp == NULL){  
        printf("Error while opening the file\n");  
        exit(0);  
    }
```

```
    while((c = fgetc(fp)) != EOF) {  
        for(i = 0; i < 6; ++i){  
            if(c == operators[i])  
                printf("%c is operator\n", c);  
        }
```

```
        if(isalnum(c)) {  
            buffer[j++] = c;  
        } else if((c == ' ' || c == '\t' || c == '\n') && (j != 0)) {  
            buffer[j] = '\0';  
            j = 0;
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
if(isKeyword(buffer) == 1)
    printf("%s is keyword\n", buffer);
else
    printf("%s is identifier\n", buffer);
}
```

```
}
fclose(fp);
return 0;
}
```

Output

Input-void main()

```
{
int a, b, c;
c = a + b;
}
```

```
christy@christy-VirtualBox:~$ gcc lex.c
c Rhythmbox isty-VirtualBox:~$ ./a.out
void is keyword
main is identifier
int is keyword
a is identifier
b is identifier
c is identifier
c is identifier
= is operator
a is identifier
+ is operator
b is identifier
christy@christy-VirtualBox:~$
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

2. Implement a Lexical Analyzer for a given program using Lex Tool

Program:

```
%{  
int COMMENT=0;  
%}  
identifier [a-zA-Z][a-zA-Z0-9]*  
%%  
#.* {printf("\n%s is a preprocessor directive",yytext);}  
int |  
float |  
char |  
double |  
while |  
for |  
struct |  
typedef |
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

do |

if |

break |

continue |

void |

switch |

return |

else |

goto {printf("\n\t%s is a keyword",yytext);}

"/*" {COMMENT=1;} {printf("\n\t %s is a COMMENT",yytext);}

{identifier}\({if(!COMMENT)printf("\nFUNCTION \n\t%s",yytext);}

\{ {if(!COMMENT)printf("\n BLOCK BEGINS");}

\} {if(!COMMENT)printf("BLOCK ENDS ");}

{identifier}(\[[0-9]*\])? {if(!COMMENT) printf("\n %s IDENTIFIER",yytext);}

"\.*\" {if(!COMMENT)printf("\n\t %s is a STRING",yytext);}

[0-9]+ {if(!COMMENT) printf("\n %s is a NUMBER ",yytext);}



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
\)(\:)? {if(!COMMENT)printf("\n\t");ECHO;printf("\n");}
```

```
\( ECHO;
```

```
= {if(!COMMENT)printf("\n\t %s is an ASSIGNMENT OPERATOR",yytext);}
```

```
\<= |
```

```
\>= |
```

```
\< |
```

```
== |
```

```
\> {if(!COMMENT) printf("\n\t%s is a RELATIONAL OPERATOR",yytext);}
```

```
%%
```

```
int main(int argc, char **argv)
```

```
{
```

```
FILE *file;
```

```
file=fopen("var.c","r");
```

```
if(!file)
```

```
{
```

```
printf("could not open the file");
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
exit(0);  
  
}  
  
yyin=file;  
  
yylex();  
  
printf("\n");  
  
return(0);  
  
}  
  
int yywrap()  
{  
  
return(1);  
  
}
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

OUTPUT:

```
l2sys29@l2sys29-Veriton-M275:~/Desktop/syedvirus$ lex exp3_lex.l
l2sys29@l2sys29-Veriton-M275:~/Desktop/syedvirus$ cc lex.yy.c
l2sys29@l2sys29-Veriton-M275:~/Desktop/syedvirus$ ./a.out

#include<stdio.h> is a preprocessor directive
#include<conio.h> is a preprocessor directive
    void is a keyword
FUNCTION
main(
)

BLOCK BEGINS
    int is a keyword
a IDENTIFIER,
b IDENTIFIER,
c IDENTIFIER;

a IDENTIFIER
= is an ASSIGNMENT OPERATOR
1 is a NUMBER ;

b IDENTIFIER
= is an ASSIGNMENT OPERATOR
2 is a NUMBER ;

c IDENTIFIER
= is an ASSIGNMENT OPERATOR
a IDENTIFIER+
b IDENTIFIER;

FUNCTION
printf(
    "Sum:%d" is a STRING,
c IDENTIFIER
)
;
BLOCK ENDS
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

3. Write a lex program to display the number of lines, words and characters in an input text.

Program:

`/*lex code to count the number of lines,
tabs and spaces used in the input*/`

```
%{  
#include<stdio.h>  
int lc=0, sc=0, tc=0, ch=0; /*Global variables*/  
%}
```

`/*Rule Section*/`

```
%%  
\n lc++; //line counter  
([ ])+ sc++; //space counter  
\t tc++; //tab counter  
. ch++; //characters counter  
%%
```

```
int main()  
{  
// The function that starts the analysis  
yylex();
```

```
printf("\nNo. of lines=%d", lc);  
printf("\nNo. of spaces=%d", sc);
```




Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
printf("\nNo. of tabs=%d", tc);  
printf("\nNo. of other characters=%d", ch);  
  
}
```

OUTPUT:

```
lab2@csit2pc23:~$ lex gfg.l  
lab2@csit2pc23:~$ cc lex.yy.c -lfl  
lab2@csit2pc23:~$ ./a.out  
Geeks for      Geeks  
gfg   gfg  
  
No. of lines=2  
No. of spaces=4  
No. of tabs=1  
No. of other characters=19lab2@csit2pc23:~$
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

4. Write a LEX Program to convert the substring abc to ABC from the given input string.

Program

`/* lex code to check for characters other than alphabets in a given string */`

```
%{
int flag = 0;
}%

%%

[\n] {
    flag==0?printf("Only alphabets present\n"):
    printf("Other characters are also present\n");
    flag = 0;
}

[^a-zA-Z] {flag = 1;}

. {}

%%

int yywrap(void) {}

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



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
return 0;  
}
```

OUTPUT:

```
abhijeet@fornax:~/gfg$ lex q3.1  
abhijeet@fornax:~/gfg$ cc lex.yy.c  
abhijeet@fornax:~/gfg$ ./a.out  
geeksforgeeks  
only alphabets present  
geek12  
other characters are also present  
lyouareawesome  
other characters are also present  
youareawesome  
only alphabets present  
|
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

5. Write a lex program to find out total number of vowels and consonants from the given input string.

Program:

```
%{  
    int vow_count=0;  
    int const_count =0;  
}%  
  
%%  
[aeiouAEIOU] {vow_count++;}  
[a-zA-Z] {const_count++;}  
%%  
int yywrap(){}  
int main()  
{  
    printf("Enter the string of vowels and consonants:");  
    yylex();  
    printf("Number of vowels are: %d\n", vow_count);  
    printf("Number of consonants are: %d\n", const_count);  
    return 0;  
}
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

OUTPUT:

```
lab2@lab2pc6: ~  
lab2@lab2pc6:~$ lex vowel.l  
lab2@lab2pc6:~$ cc lex.yy.c -lfl  
lab2@lab2pc6:~$ ./a.out  
Enter the string of vowels and consonents:geeksforgeeks  
  
The number of vowels are: 5  
The number of consonants are: 8  
lab2@lab2pc6:~$
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

6. Generate a YACC specification to recognize a valid arithmetic expression that uses operators +, −, *, / and parenthesis.

Program:

Lexical Analyzer Source Code:

```
%{
/* Definition section*/
#include "y.tab.h"
extern yylval;
}%

%%

[0-9]+ {
    yylval = atoi(yytext);
    return NUMBER;
}

[a-zA-Z]+ { return ID; }
[ \t]+ ; /*For skipping whitespaces*/

\n { return 0; }
. { return yytext[0]; }

%%
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

PARSER SOURCE CODE:

```
%{
/* Definition section */
#include <stdio.h>
}%

%token NUMBER ID
// setting the precedence
// and associativity of operators
%left '+' '-'
%left '*' '/'

/* Rule Section */
%%
E : T {
    printf("Result = %d\n", $$);
    return 0;
}

T :
T '+' T { $$ = $1 + $3; }
| T '-' T { $$ = $1 - $3; }
| T '*' T { $$ = $1 * $3; }
| T '/' T { $$ = $1 / $3; }
| '-' NUMBER { $$ = -$2; }
| '-' ID { $$ = -$2; }
| '(' T ')' { $$ = $2; }
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
| NUMBER { $$ = $1; }
```

```
| ID { $$ = $1; };
```

```
% %
```

```
int main() {
```

```
    printf("Enter the expression\n");
```

```
    yyparse();
```

```
}
```

```
/* For printing error messages */
```

```
int yyerror(char* s) {
```

```
    printf("\nExpression is invalid\n");
```

```
}
```




Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

OUTPUT:

```
aashutosh@ubuntu:~/Desktop/lex-Yacc_prgms$ lex evaluate_exp.l
aashutosh@ubuntu:~/Desktop/lex-Yacc_prgms$ yacc -d evaluate_exp.y
aashutosh@ubuntu:~/Desktop/lex-Yacc_prgms$ cc lex.yy.c y.tab.c -ll
evaluate_exp.l:4:8: warning: type defaults to 'int' in declaration of 'yylval'
[-Wimplicit-int]
extern yyval;
      ^~~~~~
y.tab.c: In function 'yyparse':
y.tab.c:1124:16: warning: implicit declaration of function 'yylex' [-Wimplicit-
function-declaration]
    yychar = yylex ();
              ^~~~~
y.tab.c:1314:7: warning: implicit declaration of function 'yyerror'; did you me
an 'yyerrok'? [-Wimplicit-function-declaration]
    yyerror (YY_("syntax error"));
    ^~~~~~
    yyerrok
aashutosh@ubuntu:~/Desktop/lex-Yacc_prgms$ ./a.out
Enter the expression
7*(5-3)/2
Result = 7
aashutosh@ubuntu:~/Desktop/lex-Yacc_prgms$ ./a.out
Enter the expression
6/((3-2)*(-5+2))
Result = -2
aashutosh@ubuntu:~/Desktop/lex-Yacc_prgms$
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

7. Generate a YACC specification to recognize a valid identifier which starts with a letter followed by any number of letters or digits.

Program:

LEX PART:

```
%{  
  
    #include "y.tab.h"  
  
}%  
  
%%  
  
[a-zA-Z_][a-zA-Z_0-9]* return letter;  
  
[0-9]          return digit;  
  
.              return yytext[0];  
  
\n            return 0;  
  
%%  
  
int yywrap()  
{  
  
return 1;
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

}

YACC PART:

%{

#include<stdio.h>

int valid=1;

%}

%token digit letter

%%

start : letter s

s : letter s

| digit s

|

;

%%

int yyerror()

{



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
printf("\nIts not a identifier!\n");

valid=0;

return 0;
}

int main()
{
printf("\nEnter a name to tested for identifier ");

yyparse();

if(valid)
{
printf("\nIt is a identifier!\n");
}
}
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

OUTPUT:

```
virus@virus-desktop: ~/Desktop/syedvirus
virus@virus-desktop:~/Desktop/syedvirus$ yacc -d 4b.y
virus@virus-desktop:~/Desktop/syedvirus$ lex 4b.l
virus@virus-desktop:~/Desktop/syedvirus$ gcc lex.yy.c y.tab.c -w
virus@virus-desktop:~/Desktop/syedvirus$ ./a.out

Enter a name to tested for identifier abc

It is a identifier!
virus@virus-desktop:~/Desktop/syedvirus$ ./a.out

Enter a name to tested for identifier _abc

It is a identifier!
virus@virus-desktop:~/Desktop/syedvirus$ ./a.out

Enter a name to tested for identifier 848_f

Its not a identifier!
virus@virus-desktop:~/Desktop/syedvirus$
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

8. Implementation of Calculator using LEX and YACC

Program

Code.1

```
%{  
    #include<stdio.h>  
    #include "y.tab.h"  
    extern int yylval;  
}%  
  
%%  
[0-9]+ {  
    yylval = atoi(yytext);  
    return digit;  
}  
[\t ]+ ;  
.      return yytext[0];  
\n     return 0;  
%%
```

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

code.y

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



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
%%  
start: E      { printf("%d\n", $1); }  
      ;  
E:    E '+' T      { $$ = $1 + $3; }  
      | E '-' T      { $$ = $1 - $3; }  
      | T  
      ;  
T:    T '*' F      { $$ = $1 * $3; }  
      | T '/' F      { if($3) $$ = $1 / $3;  
                      else return yyerror("Divide by zero"); }  
      | F  
      ;  
F:    '(' E ')'      { $$ = $2; }  
      | digit        { $$ = $1; }  
      ;  
%%
```

```
int yyerror(char* s) {  
    fprintf(stderr, "%s\n", s);  
    return 0;  
}
```

```
int main() {  
    printf("Input the expression: ");  
    yyparse();  
}
```



Govt. Model Engineering College, Thrikkakara

Managed by Institute of Human Resources Development

A Govt. of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

Output

```
christy@christy-VirtualBox:~$ lex calculator.l
christy@christy-VirtualBox:~$ bison -dy calculator.y
christy@christy-VirtualBox:~$ gcc lex.yy.c y.tab.c
y.tab.c: In function 'yyparse':
y.tab.c:1017:16: warning: implicit declaration of function 'yylex' [-Wimplicit-
function-declaration]
 1017 |         yychar = yylex ();
      |                  ^~~~~~
calculator.y:15:45: warning: implicit declaration of function 'yyerror'; did yo
u mean 'yyerrok'? [-Wimplicit-function-declaration]
   15 |                 else return yyerror("Divide by zero");
      |                               ^~~~~~
      |                               yyerrok
christy@christy-VirtualBox:~$ ./a.out
Input the expression: 6-3
3
christy@christy-VirtualBox:~$
```




Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

9. Convert the BNF rules into YACC form and write code to generate abstract syntax tree

Program:

Code.1

```
%{
#include "y.tab.h"
#include <stdio.h>
#include <string.h>
int LineNo=1;
}%

identifier [a-zA-Z][_a-zA-Z0-9]*
number [0-9]+|([0-9]*\.[0-9]+)

%%

main\(\) return MAIN;
if return IF;
else return ELSE;
while return WHILE;
int |
char |
float return TYPE;
{identifier} {strcpy(yylval.var,yytext);
return VAR;}
{number} {strcpy(yylval.var,yytext);
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
return NUM;}  
\< |  
\> |  
\>= |  
\<= |  
== {strcpy(yylval.var,yytext);  
return RELOP;}  
[ \t] ;  
\n LineNo++;  
. return yytext[0];
```

```
%%
```

```
int yywrap(void){};
```

code.y

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

```
int yylex();  
int yyerror();  
struct quad  
{  
    char op[5];  
    char arg1[10];
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
char arg2[10];  
char result[10];  
} QUAD[30];
```

```
struct stack  
{  
    int items[100];  
    int top;  
} stk;
```

```
int Index=0,tIndex=0,StNo,Ind,tInd;  
extern int LineNo;
```

```
void push(int data)  
{  
    stk.top++;  
    if(stk.top==100)  
    {  
        printf("\n Stack overflow\n");  
        exit(0);  
    }  
    stk.items[stk.top]=data;  
}
```

```
void AddQuadruple(char op[5],char arg1[10],char arg2[10],char result[10])  
{  
    strcpy(QUAD[Index].op,op);
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
strcpy(QUAD[Index].arg1,arg1);
strcpy(QUAD[Index].arg2,arg2);
sprintf(QUAD[Index].result,"t%d",tIndex++);
strcpy(result,QUAD[Index++].result);
}
```

```
int pop()
{
    int data;
    if(stk.top==-1)
    {
        printf("\n Stack underflow\n");
        exit(0);
    }
    data=stk.items[stk.top--];
    return data;
}
```

```
int yyerror()
{
    printf("\n Error on line no:%d",LineNo);
}
```

```
%}
```

```
%union
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
{  
char var[10];  
}
```

%token <var> NUM VAR RELOP

%token MAIN IF ELSE WHILE TYPE

%type <var> EXPR ASSIGNMENT CONDITION IFST ELSEST
WHILELOOP

%left '-' '+'

%left '*' '/'

%%

PROGRAM : MAIN BLOCK

;

BLOCK: '{' CODE '}'

;

CODE: BLOCK

| STATEMENT CODE

| STATEMENT

;

STATEMENT: DESCT ';

| ASSIGNMENT ';

| CONDST

| WHILEST

;



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

DESCT: TYPE VARLIST

;

VARLIST: VAR ',' VARLIST

| VAR

;

ASSIGNMENT: VAR '=' EXPR{

strcpy(QUAD[Index].op,"=");

strcpy(QUAD[Index].arg1,\$3);

strcpy(QUAD[Index].arg2,"");

strcpy(QUAD[Index].result,\$1);

strcpy(\$\$,QUAD[Index++].result);

}

;

EXPR: EXPR '+' EXPR {AddQuadruple("+",\$1,\$3,\$\$);}

| EXPR '-' EXPR {AddQuadruple("-", \$1,\$3,\$\$);}

| EXPR '*' EXPR {AddQuadruple("*", \$1,\$3,\$\$);}

| EXPR '/' EXPR {AddQuadruple("/", \$1,\$3,\$\$);}

| '-' EXPR {AddQuadruple("UMIN", \$2, "", \$\$);}

| '(' EXPR ')' {strcpy(\$\$, \$2);}

| VAR

| NUM

;

CONDST: IFST{

Ind=pop();

sprintf(QUAD[Ind].result,"%d",Index);

Ind=pop();

sprintf(QUAD[Ind].result,"%d",Index);



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

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



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

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




Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
strcpy(QUAD[Index].arg2,"");  
strcpy(QUAD[Index].result,"-1");  
push(Index);  
Index++;  
}  
;  
  
%%
```

```
extern FILE *yyin;  
int main(int argc,char *argv[])  
{  
    FILE *fp;  
    int i;  
    if(argc>1)  
    {  
        fp=fopen(argv[1],"r");  
        if(!fp)  
        {  
            printf("\n File not found");  
            exit(0);  
        }  
        yyin=fp;  
    }  
    yyparse();  
}
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
        printf("\n\n\t\t ----- \n\t\t Pos Operator Arg1 Arg2
Result\n\t\t -----");
    for(i=0;i<Index;i++)
    {
        printf("\n\t\t %d\t %s\t %s\t
%s\t%s",i,QUAD[i].op,QUAD[i].arg1,QUAD[i].arg2,QUAD[i].result);
    }
    printf("\n\t\t -----");
    printf("\n\n");
    return 0;
}
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

Output

```
christy@christy-VirtualBox:~$ ./a.out input.c

-----
Pos Operator Arg1 Arg2 Result
-----
0      <      a      b      t0
1      ==     t0     FALSE  5
2      +      a      b      t1
3      =      t1     a
4      GOTO
5      <      a      b      t2
6      ==     t2     FALSE  10
7      +      a      b      t3
8      =      t3     a
9      GOTO
10     <=     a      b      t4
11     ==     t4     FALSE  15
12     -      a      b      t5
13     =      t5     c
14     GOTO
15     +      a      b      t6
16     =      t6     c
-----

christy@christy-VirtualBox:~$
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

10. Write program to find ϵ – closure of all states of any given NFA with ϵ – transition

Program

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

char result[20][20],copy[3],states[20][20];

void add_state(char a[3],int i){
    strcpy(result[i],a);
}

void display(int n){
    int k=0;
    printf("\nEpsilon closure of %s = { ",copy);
    while(k < n){
        printf(" %s",result[k]);
        k++;
    }
    printf(" } \n");
}

int main(){
    FILE *INPUT;
    INPUT=fopen("input.txt","r");
    char state[3];
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
int end,i=0,n,k=0;
char state1[3],input[3],state2[3];
printf("\n Enter the no of states: ");
scanf("%d",&n);
printf("\n Enter the states:");
for(k=0;k<3;k++){
    scanf("%s",states[k]);
}

for( k=0;k<n;k++){
    i=0;
    strcpy(state,states[k]);
    strcpy(copy,state);
    add_state(state,i++);
    while(1){
        end = fscanf(INPUT,"%s%s%s",state1,input,state2);
        if (end == EOF ){
            break;
        }

        if( strcmp(state,state1) == 0 ){
            if( strcmp(input,"e") == 0 ) {
                add_state(state2,i++);
                strcpy(state, state2);
            }
        }
    }
}
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
    }  
    display(i);  
    rewind(INPUT);  
}  
  
return 0;  
}
```

Output

```
C:\Windows\System32\cmd.exe  
Microsoft Windows [Version 10.0.19042.1288]  
(c) Microsoft Corporation. All rights reserved.  
  
D:\CD Lab>gcc epsilonclosure.c  
  
D:\CD Lab>a  
  
Enter the no of states: 3  
  
Enter the states:q0 q1 q2  
  
Epsilon closure of q0 = {  q0 q1 q2 }  
Epsilon closure of q1 = {  q1 q2 }  
Epsilon closure of q2 = {  q2 }  
  
D:\CD Lab>
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

11.Write program to convert NFA with ϵ transition to NFA without ϵ transition.

Program

```
#include<stdio.h>
#include<stdlib.h>
struct node
{
    int st;
    struct node *link;
};

void findclosure(int,int);
void insert_trantbl(int ,char, int);
int findalpha(char);
void findfinalstate(void);
void unionclosure(int);
void print_e_closure(int);
static int set[20],nostate,noalpha,s,notransition,nofinal,start,finalstate[20],c,r,buffer[20];
char alphabet[20];
static int e_closure[20][20]={0};
struct node * transition[20][20]={NULL};
void main()
{
    int i,j,k,m,t,n;

    struct node *temp;
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
printf("enter the number of alphabets?\n");
scanf("%d",&noalpha);
getchar();
printf("NOTE:- [ use letter e as epsilon]\n");
```

```
printf("NOTE:- [e must be last character ,if it is present]\n");
```

```
printf("\nEnter alphabets?\n");
for(i=0;i<noalpha;i++)
{
```

```
    alphabet[i]=getchar();
    getchar();
```

```
}
printf("Enter the number of states?\n");
scanf("%d",&nostate);
printf("Enter the start state?\n");
scanf("%d",&start);
printf("Enter the number of final states?\n");
scanf("%d",&nofinal);
printf("Enter the final states?\n");
for(i=0;i<nofinal;i++)
    scanf("%d",&finalstate[i]);
printf("Enter no of transition?\n");
scanf("%d",&notransition);
```

```
    printf("NOTE:- [Transition is in the form--> qno    alphabet
qno]\n",notransition);
```




Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
printf("NOTE:- [States number must be greater than zero]\n");
printf("\nEnter transition?\n");
for(i=0;i<notransition;i++)
{

    scanf("%d %c%d",&r,&c,&s);
    insert_trantbl(r,c,s);

}

printf("\n");

for(i=1;i<=nostate;i++)
{
    c=0;
    for(j=0;j<20;j++)

    {
        buffer[j]=0;
        e_closure[i][j]=0;
    }
    findclosure(i,i);
}
printf("Equivalent NFA without epsilon\n");
printf("-----\n");
printf("start state:");
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
print_e_closure(start);
printf("\nAlphabets:");
for(i=0;i<noalpha;i++)
    printf("%c ",alphabet[i]);
printf("\n States :" );
for(i=1;i<=nostate;i++)
    print_e_closure(i);

printf("\nTntransitions are...\n");

for(i=1;i<=nostate;i++)
{

    for(j=0;j<noalpha-1;j++)
    {
        for(m=1;m<=nostate;m++)
            set[m]=0;
        for(k=0;e_closure[i][k]!=0;k++)
        {

            t=e_closure[i][k];
            temp=transition[t][j];
            while(temp!=NULL)
            {

                unionclosure(temp->st);
                temp=temp->link;
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
        }
    }
    printf("\n");
    print_e_closure(i);
    printf("%c\t",alphabet[j] );
    printf("{}");
    for(n=1;n<=nostate;n++)
    {
        if(set[n]!=0)
            printf("q%d,",n);
    }
    printf("{}");
}
}
printf("\n Final states:");
findfinalstate();

}

void findclosure(int x,int sta)
{
    struct node *temp;
    int i;
    if(buffer[x])
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
        return;
    e_closure[sta][c++]=x;
    buffer[x]=1;
    if(alphabet[noalpha-1]=='e' && transition[x][noalpha-1]!=NULL)
    {
        temp=transition[x][noalpha-1];
        while(temp!=NULL)
        {
            findclosure(temp->st,sta);
            temp=temp->link;
        }
    }
}

void insert_trantbl(int r,char c,int s)
{
    int j;
    struct node *temp;
    j=findalpha(c);
    if(j==999)
    {
        printf("error\n");
        exit(0);
    }
    temp=(struct node *) malloc(sizeof(struct node));
    temp->st=s;
    temp->link=transition[r][j];
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
        transition[r][j]=temp;
    }

int findalpha(char c)
{
    int i;
    for(i=0;i<noalpha;i++)
        if(alphabet[i]==c)
            return i;

    return(999);

}

void unionclosure(int i)
{
    int j=0,k;
    while(e_closure[i][j]!=0)
    {
        k=e_closure[i][j];
        set[k]=1;
        j++;
    }
}

void findfinalstate()
{
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
int i,j,k,t;
for(i=0;i<nofinal;i++)
{
    for(j=1;j<=nostate;j++)
    {
        for(k=0;e_closure[j][k]!=0;k++)
        {
            if(e_closure[j][k]==finalstate[i])
            {
                print_e_closure(j);
            }
        }
    }
}

}

void print_e_closure(int i)
{
    int j;
    printf("{");
    for(j=0;e_closure[i][j]!=0;j++)
        printf("q%d,",e_closure[i][j]);
    printf("}\t");
}
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

Output

```
D:\CD Lab>a
enter the number of alphabets?
4
NOTE:- [ use letter e as epsilon]
NOTE:- [e must be last character ,if it is present]

Enter alphabets?
a b c e
Enter the number of states?
3
Enter the start state?
1
Enter the number of final states?
1
Enter the final states?
3
Enter no of transition?
5
NOTE:- [Transition is in the form--> qno  alphabet  qno]
NOTE:- [States number must be greater than zero]

Enter transition?
1 a 1
1 e 2
2 b 2
2 e 3
3 c 3

Equivalent NFA without epsilon
-----
start state:{q1,q2,q3,}
Alphabets:a b c e
States :{q1,q2,q3,}  {q2,q3,}  {q3,}
Transitions are...:

{q1,q2,q3,}  a  {q1,q2,q3,}
{q1,q2,q3,}  b  {q2,q3,}
{q1,q2,q3,}  c  {q3,}
{q2,q3,}     a  {}
{q2,q3,}     b  {q2,q3,}
{q2,q3,}     c  {q3,}
{q3,}        a  {}
{q3,}        b  {}
{q3,}        c  {q3,}
Final states:{q1,q2,q3,}  {q2,q3,}  {q3,}
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

12. Write program to convert NFA to DFA

Program

```
#include<stdio.h>
#include<stdlib.h>
struct node
{
    int st;
    struct node *link;
};
struct node1
{
    int nst[20];
};

void insert(int ,char, int);
int findalpha(char);
void findfinalstate(void);
int insertdfastate(struct node1);
int compare(struct node1,struct node1);
void printnewstate(struct node1);
static int set[20],nostate,noalpha,s,notransition,nofinal,start,finalstate[20],c,r,buffer[20];
int complete=-1;
char alphabet[20];
static int eclosure[20][20]={0};
struct node1 hash[20];
struct node * transition[20][20]={NULL};
```




Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
void main()
{
    int i,j,k,m,t,n,l;
    struct node *temp;
    struct node1 newstate={0},tmpstate={0};

    printf("Enter the number of alphabets?\n");
    printf("NOTE:- [ use letter e as epsilon]\n");
    printf("NOTE:- [e must be last character ,if it is present]\n");
    printf("\nEnter No of alphabets and alphabets?\n");
    scanf("%d",&noalpha);
    getchar();
    for(i=0;i<noalpha;i++)
    {

        alphabet[i]=getchar();
        getchar();
    }
    printf("Enter the number of states?\n");
    scanf("%d",&nostate);
    printf("Enter the start state?\n");
    scanf("%d",&start);
    printf("Enter the number of final states?\n");
    scanf("%d",&nofinal);
    printf("Enter the final states?\n");
    for(i=0;i<nofinal;i++)
        scanf("%d",&finalstate[i]);
    printf("Enter no of transition?\n");

    scanf("%d",&notransition);
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
printf("NOTE:- [Transition is in the form-> qno alphabet  
qno]\n",notransition);  
printf("NOTE:- [States number must be greater than zero]\n");  
printf("\nEnter transition?\n");
```

```
for(i=0;i<notransition;i++)  
{
```

```
scanf("%d %c%d",&r,&c,&s);  
insert(r,c,s);
```

```
}  
for(i=0;i<20;i++)  
{  
for(j=0;j<20;j++)  
hash[i].nst[j]=0;  
}  
complete=-1;  
i=-1;  
printf("\nEquivalent DFA.....\n");  
printf(".....\n");
```

```
printf("Trnsitions of DFA\n");
```

```
newstate.nst[start]=start;  
insertdfastate(newstate);  
while(i!=complete)  
{
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
i++;
newstate=hash[i];
for(k=0;k<noalpha;k++)
{
c=0;
for(j=1;j<=nostate;j++)
set[j]=0;
for(j=1;j<=nostate;j++)
{
l=newstate.nst[j];
if(l!=0)
{
temp=transition[l][k];
while(temp!=NULL)
{
if(set[temp->st]==0)
{
c++;
set[temp->st]=temp->st;
}
temp=temp->link;
}
}
}
printf("\n");
if(c!=0)
{
for(m=1;m<=nostate;m++)
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
tmpstate.nst[m]=set[m];

insertdfastate(tmpstate);

printnewstate(newstate);
printf("%c\t",alphabet[k]);
printnewstate(tmpstate);
printf("\n");
}
else
{
printnewstate(newstate);
printf("%c\t", alphabet[k]);
printf("NULL\n");
}

}
}
printf("\nStates of DFA:\n");
for(i=0;i<=complete;i++)
printnewstate(hash[i]);
printf("\n Alphabets:\n");
for(i=0;i<noalpha;i++)
printf("%c\t",alphabet[i]);
printf("\n Start State:\n");
printf("q%d",start);
printf("\nFinal states:\n");
findfinalstate();

}
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
int insertdfastate(struct node1 newstate)
{
    int i;
    for(i=0;i<=complete;i++)
    {
        if(compare(hash[i],newstate))
            return 0;
    }
    complete++;
    hash[complete]=newstate;
    return 1;
}

int compare(struct node1 a,struct node1 b)
{
    int i;

    for(i=1;i<=nostate;i++)
    {
        if(a.nst[i]!=b.nst[i])
            return 0;
    }
    return 1;
}

void insert(int r,char c,int s)
{
    int j;
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
    struct node *temp;
    j=findalpha(c);
    if(j==999)
    {
    printf("error\n");
    exit(0);
    }
    temp=(struct node *) malloc(sizeof(struct node));
    temp->st=s;
    temp->link=transition[r][j];
    transition[r][j]=temp;
}

int findalpha(char c)
{
    int i;
    for(i=0;i<noalpha;i++)
    if(alphabet[i]==c)
        return i;

    return(999);

}

void findfinalstate()
{
    int i,j,k,t;
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
for(i=0;i<=complete;i++)
{
for(j=1;j<=nostate;j++)
{
for(k=0;k<nofinal;k++)
{
if(hash[i].nst[j]==finalstate[k])
{
printnewstate(hash[i]);
printf("\t");
j=nostate;
break;
}
}
}
}
}
```

```
void printnewstate(struct node1 state)
{
int j;
printf(" {");
for(j=1;j<=nostate;j++)
{
if(state.nst[j]!=0)
printf("q%d,",state.nst[j]);
}
printf("}\t");
}
```



Govt. Model Engineering College, Thrikkakara
Managed by Institute of Human Resources Development
A Govt. of Kerala Establishment
Department of Computer Engineering
B.Tech in Computer Science and Engineering

}
Output

```
C:\Windows\System32\cmd.exe
Microsoft Windows [Version 10.0.19042.1288]
(c) Microsoft Corporation. All rights reserved.

D:\CD Lab>gcc nfatodfa.c

D:\CD Lab>a
Enter the number of alphabets?
NOTE:- [ use letter e as epsilon]
NOTE:- [e must be last character ,if it is present]

Enter No of alphabets and alphabets?
2
a b
Enter the number of states?
4
Enter the start state?
1
Enter the number of final states?
2
Enter the final states?
3 4
Enter no of transition?
8
NOTE:- [Transition is in the form[C0> qno alphabet qno]
NOTE:- [States number must be greater than zero]

Enter transition?
1 a 1
1 b 1
1 a 2
2 b 2
2 a 3
3 a 4
3 b 4
4 b 3
```

```
C:\Windows\System32\cmd.exe
Equivalent DFA.....
.....
Transitions of DFA

{q1,}   a       {q1,q2,}
{q1,}   b       {q1,}
{q1,q2,} a       {q1,q2,q3,}
{q1,q2,} b       {q1,q2,}
{q1,q2,q3,} a    {q1,q2,q3,q4,}
{q1,q2,q3,} b    {q1,q2,q4,}
{q1,q2,q3,q4,} a {q1,q2,q3,q4,}
{q1,q2,q3,q4,} b {q1,q2,q3,q4,}
{q1,q2,q4,} a    {q1,q2,q3,}
{q1,q2,q4,} b    {q1,q2,q3,}

States of DFA:
{q1,} {q1,q2,} {q1,q2,q3,} {q1,q2,q3,q4,} {q1,q2,q4,}
Alphabets:
a b
Start State:
q1
Final states:
{q1,q2,q3,} {q1,q2,q3,q4,} {q1,q2,q4,}
D:\CD Lab>
```




Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

13. Write program to minimize any given DFA.

Program

```
#include <stdio.h>
#include <stdlib.h>
static int nostate,noalpha,s,notransition,nofinal,start,finalstate[20],r;
char alphabet[20];
int transition_map[30][30], table[30][30], nonfinalstate[20],
partition[20][20];
int findalpha(char a)
{
    int i;
    for(i=0;i<noalpha;i++)
        if(alphabet[i]==a)
            return i;
    return(-1);
}
int main() {
    int i,j,p[20],q[20],k;
    char a;
    for(i=0;i<30;i++){
        for(j=0;j<30;j++)
            transition_map[i][j]=-1;
    }
    printf("Enter the number of alphabets: ");
    scanf("%d",&noalpha);
    getchar();
    printf("Enter the alphabets: \n");
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
for(i=0;i<noalpha;i++)
{
    alphabet[i]=getchar();
    getchar();
}
printf("Enter the number of states: ");
scanf("%d",&nostate);
printf("Enter the start state: ");
scanf("%d",&start);
printf("Enter the number of final states: ");
scanf("%d",&nofinal);
printf("Enter the final states:\n");
for(i=0;i<nofinal;i++)
    scanf("%d",&finalstate[i]);
printf("Enter no of transition: ");
scanf("%d",&notransition);
printf("Enter Transition in the form -> state alphabet next_state\n");
for(i=0;i<notransition;i++)
{
    scanf("%d %c %d",&r,&a,&s);
    j=findalpha(a);
    if (j==-1){printf("\nerror\n"); exit(1);}
    transition_map[r][j] = s;
}
for(i=0;i<nostate;i++){
    for(j=0;j<i;j++){
        table[i][j]=0;
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
}  
}  
int f=0;  
k=0;  
for(i=0;i<nostate;i++){  
    f=0;  
    for(j=0;j<nofinal;j++){  
        if(i==finalstate[j])  
            { f=1;break;}  
    }  
    if(f==0){nonfinalstate[k++]=i;}  
}  
for(i=0;i<nofinal;i++){  
    for(j=0;j<(nostate-nofinal);j++){  
        if(nonfinalstate[j]>finalstate[i])  
            table[nonfinalstate[j]][finalstate[i]]=1;  
        else  
            table[finalstate[i]][nonfinalstate[j]]=1;  
    }  
}  
int change = 1;  
while(change==1){  
    change=0;  
    for(i=0;i<nostate;i++){  
        for(j=0;j<i;j++){  
            if(table[i][j]!=1){  
                for(k=0;k<noalpha;k++){  
                    p[k]=transition_map[i][k];
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
for(k=0;k<noalpha;k++)
    q[k]=transition_map[j][k];
for(k=0;k<noalpha;k++){
    if(p[k]>q[k]){
        if (table[p[k]][q[k]]==1){
            change=1;
            table[i][j]=1;
            break;
        }
    }
    else if(p[k]<q[k]){
        if (table[q[k]][p[k]]==1){
            change=1;
            table[i][j]=1;
            break;
        }
    }
}
}
}
}
k=0;
for(i=0;i<nostate;i++){
    k=0;
    partition[i][k++]=i;
    for(j=0;j<i;j++)
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
        if(table[i][j]==0){
            partition[i][k++]=j;
        }
    partition[i][k]=-1;
}
int newstate[20]={0},m;

printf("\nStates in minimized DFA");
printf("\n-----\n");
for(i=nostate-1;i>=0;i--){
    k=0;
    if(newstate[i]==0){
        printf("{");
        while(partition[i][k]!=-1){
            if(newstate[partition[i][k]]==0){
                newstate[partition[i][k]]=1;
                printf("q%d ",partition[i][k]);
            }
            k++;
        }
        printf("}\n");
    }
}
return 0;
}
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

Output

```
C:\Windows\System32\cmd.exe
Microsoft Windows [Version 10.0.19042.1288]
(c) Microsoft Corporation. All rights reserved.

D:\CD Lab>gcc 10_1.4_CODE.c

D:\CD Lab>a
Enter the number of alphabets: 2
Enter the alphabets:
0
1
Enter the number of states: 5
Enter the start state: 0
Enter the number of final states: 1
Enter the final states:
4
Enter no of transition: 10
Enter Transition in the form [C] state alphabet next_state
0 0 1
0 1 2
1 0 1
1 1 3
2 0 1
2 1 2
3 0 1
3 1 4
4 0 1
4 1 2

States in minimized DFA
-----
{q4 }
{q3 }
{q2 q0 }
{q1 }
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

14. Write program to find Simulate First and Follow of any given grammar

Program

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

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

```
int n;
```

```
char prods[50][50];
```

```
char firsts[26][50];
```

```
int is_first_done[26];
```

```
char follows[26][50];
```

```
int is_follow_done[26];
```

```
int isTerminal(char c)
```

```
{
```

```
    if (c < 65 || c > 90)
```

```
        return 1;
```

```
    return 0;
```

```
}
```

```
void first(char nonterm)
```

```
{
```

```
    int index = 0;
```

```
    char curr_firsts[50];
```

```
    for (int i = 0; i < n; i++)
```

```
    {
```

```
        if (prods[i][0] == nonterm)
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
{
```

```
int curr_prod_index = 2;
```

```
int flag = 0;
```

```
while (prods[i][curr_prod_index] != '\0' && flag == 0)
```

```
{
```

```
    flag = 1;
```

```
    if (isTerminal(prods[i][curr_prod_index]))
```

```
    {
```

```
        curr_firsts[index] = prods[i][2];
```

```
        index++;
```

```
        break;
```

```
    }
```

```
if (!is_first_done[prods[i][curr_prod_index] - 65])
```

```
    first(prods[i][curr_prod_index]);
```

```
int in = 0;
```

```
while (firsts[prods[i][curr_prod_index] - 65][in] != '\0')
```

```
{
```

```
    curr_firsts[index] = firsts[prods[i][curr_prod_index] - 65][in];
```

```
    if (firsts[prods[i][curr_prod_index] - 65][in] == 'e')
```

```
    {
```

```
        curr_prod_index++;
```

```
        flag = 0;
```

```
    }
```




Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
        index++;
        in++;
    }
}
}

curr_firsts[index] = '\0';
index++;
strcpy(firsts[nonterm - 65], curr_firsts);
is_first_done[nonterm - 65] = 1;
}

void follow(char nonterm)
{
    int index = 0;
    char curr_follows[50];
    if (nonterm == prods[0][0])
    {
        curr_follows[index] = '$';
        index++;
    }
    for (int j = 0; j < n; j++)
    {
        int k = 2;
        int include_lhs_flag;
        while (prods[j][k] != '\0')
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
{
    include_lhs_flag = 0;
    if (prods[j][k] == nonterm)
    {
        if (prods[j][k + 1] != '\0')
        {
            if (isTerminal(prods[j][k + 1]))
            {
                curr_follows[index] = prods[j][k + 1];
                index++;
                break;
            }

            int in = 0;
            while (firsts[prods[j][k + 1] - 65][in] != '\0')
            {
                if (firsts[prods[j][k + 1] - 65][in] == 'e')
                {
                    include_lhs_flag = 1;
                    in++;
                    continue;
                }

                int temp_flag = 0;
                for (int z = 0; z < index; z++)
                    if (firsts[prods[j][k + 1] - 65][in] == curr_follows[z])
                    {
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
        temp_flag = 1;
        in++;
        break;
    }
    if (temp_flag)
        continue;

    curr_follows[index] = firsts[prods[j][k + 1] - 65][in];
    index++;
    in++;
}
}

if (prods[j][k + 1] == '\0' || include_lhs_flag == 1)
{
    if (prods[j][0] != nonterm)
    {
        if (!is_follow_done[prods[j][0] - 65])
            follow(prods[j][0]);
        int x = 0;
        while (follows[prods[j][0] - 65][x] != '\0')
        {
            int temp_flag = 0;
            for (int z = 0; z < index; z++)
                if (follows[prods[j][0] - 65][x] == curr_follows[z])
                {
                    temp_flag = 1;
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
        x++;
        break;
    }
    if (temp_flag)
        continue;
    curr_follows[index] = follows[prods[j]][0] - 65][x];
    index++;
    x++;
}
}
}
}
k++;
}
}

curr_follows[index] = '\0';
index++;
strcpy(follows[nonterm - 65], curr_follows);
is_follow_done[nonterm - 65] = 1;
}

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



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
for (int i = 0; i < n; i++)
    scanf("%s", prods[i]);

for (int i = 0; i < 26; i++)
    is_first_done[i] = 0;

for (int i = 0; i < n; i++)
    if (is_first_done[prods[i][0] - 65] == 0)
        first(prods[i][0]);

for (int i = 0; i < n; i++)
    if (is_follow_done[prods[i][0] - 65] == 0)
        follow(prods[i][0]);

printf("Firsts:\n");
for (int i = 0; i < 26; i++)
    if (is_first_done[i])
        printf("%c : %s\n", i + 65, firsts[i]);

printf("Follows:\n");
for (int i = 0; i < 26; i++)
    if (is_follow_done[i])
        printf("%c : %s\n", i + 65, follows[i]);
}
```



Govt. Model Engineering College, Thrikkakara

Managed by Institute of Human Resources Development

A Govt. of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

Output

```
mec@cc-2-1: ~/CSB10
File Edit View Search Terminal Help
Enter the number of productions
8
Enter productions:
E=TR
R=+TR
R=e
T=FY
Y=*FY
Y=e
F=(E)
F=i
Firsts:
E : (i
F : (i
R : +e
T : (i
Y : *e
Follows:
E : $)
F : *+$)
R : $)
T : +$)
Y : +$)
mec@cc-2-1:~/CSB10$
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

15. Design and implement a recursive descent parser for a given grammar.

Program

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

```
char inp[100];
```

```
int len = 0;
```

```
int curr = 0;
```

```
int E();
```

```
int Z();
```

```
int main()
```

```
{
```

```
    printf("Enter input:\n");
```

```
    scanf("%s", inp);
```

```
    while (inp[len] != '\0')
```

```
        len++;
```

```
    int res = E();
```

```
    if (res == 1 && curr == len)
```

```
        printf("Input has been accepted.\n");
```

```
    else
```

```
        printf("Input has been rejected.\n");
```

```
}
```

```
int E()
```

```
{
```

```
    int result;
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
if (inp[curr] == 'i')
{
    curr++;
    result = Z();
    if (result == 1)
        return 1;
    else
        return -1;
}
return -1;
}

int Z()
{
    int result;
    if (inp[curr] == '+' && inp[curr + 1] == 'i')
    {
        curr += 2;
        result = Z();
        if (result == 1)
            return 1;
    }
    return 1;
}
```




Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

Output

```
mec@cc-2-1: ~/CSB
File Edit View Search Terminal Help
mec@cc-2-1:~/CSB$ gcc 10_3.4_PROGRAM.c
mec@cc-2-1:~/CSB$ ./a.out
Enter input:
i-i-i
Input has been rejected.
mec@cc-2-1:~/CSB$ ./a.out
Enter input:
i+i+i
Input has been accepted.
mec@cc-2-1:~/CSB$
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

16. Construct a Shift Reduce Parser for a given language.

Program

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

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

```
char inp[100];
```

```
int len;
```

```
char stack[100];
```

```
int top = 0;
```

```
void print_details(int ind, char *action)
```

```
{
```

```
    printf("$");
```

```
    for (int i = 0; i <= top; i++)
```

```
        printf("%c", stack[i]);
```

```
    printf("\t\t");
```

```
    for (int i = ind; i < len; i++)
```

```
        printf("%c", inp[i]);
```

```
    printf("$\t\t%s\n", action);
```

```
}
```

```
void check_for_reduce(int i)
```

```
{
```

```
    int flag = 1;
```

```
    while (flag)
```

```
    {
```

```
        flag = 0;
```

```
        if (stack[top - 2] == 'S' && stack[top - 1] == '+' && stack[top] == 'S')
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
{
    print_details(i + 1, "REDUCE");
    stack[top - 2] = 'S';
    top = top - 2;
    flag = 1;
}
else if (stack[top - 2] == 'S' && stack[top - 1] == '-' && stack[top] ==
'S')
{
    print_details(i + 1, "REDUCE");
    stack[top - 2] = 'S';
    top = top - 2;
    flag = 1;
}
else if (stack[top - 2] == '(' && stack[top - 1] == 'S' && stack[top] ==
'')
{
    print_details(i + 1, "REDUCE");
    stack[top - 2] = 'S';
    top = top - 2;
    flag = 1;
}
else if (stack[top] == 'i')
{
    print_details(i + 1, "REDUCE");
    stack[top] = 'S';
    flag = 1;
}
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
    }  
  }  
}  
int main()  
{  
    printf("Enter input:\n");  
    scanf("%s", inp);  
    len = strlen(inp);  
  
    printf("Stack\t\tInput\t\tAction\n");  
  
    for (int i = 0; i < len; i++)  
    {  
        print_details(i, "SHIFT");  
        stack[top] = inp[i];  
        check_for_reduce(i);  
        top++;  
    }  
    top--;  
  
    if (top == 0 && stack[0] == 'S')  
        printf("Accepted.\n");  
    else  
        printf("Rejected.\n");  
}
```

Output



Govt. Model Engineering College, Thrikkakara

Managed by Institute of Human Resources Development

A Govt. of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
File Edit View Search Terminal Help
mec@cc-2-1:~$ cd CSB10
mec@cc-2-1:~/CSB10$ gcc 10_3.3_PROGRAM.c
mec@cc-2-1:~/CSB10$ ./a.out
Enter input:
i-(i+i)
Stack      Input      Action
$          i-(i+i)$      SHIFT
$i         -(i+i)$      REDUCE
$S         -(i+i)$      SHIFT
$S-        (i+i)$      SHIFT
$S-(       i+i)$      SHIFT
$S-(i      +i)$      REDUCE
$S-(S      +i)$      SHIFT
$S-(S+     i)$      SHIFT
$S-(S+i    )$      REDUCE
$S-(S+S    )$      REDUCE
$S-(S+     )$      REDUCE
$S-(S      )$      SHIFT
$S-(S      )$      REDUCE
$S-S       $         REDUCE
Accepted.
mec@cc-2-1:~/CSB10$ gcc 10_3.3_PROGRAM.c
mec@cc-2-1:~/CSB10$ ./a.out
Enter input:
i+i*i
Stack      Input      Action
$          i+i*i$      SHIFT
$i         +i*i$      REDUCE
$S         +i*i$      SHIFT
$S+        i*i$      SHIFT
$S+i       *i$      REDUCE
$S+S       *i$      REDUCE
$S+        *i$      SHIFT
$S*S       i$      SHIFT
$S*i       $         REDUCE
Rejected.
mec@cc-2-1:~/CSB10$
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

17. Write a program to perform constant propagation.

PROGRAM CODE:

```
#include<stdio.h>
#include<string.h>
#include<ctype.h>
#include<conio.h>
void input();
void output();
void change(int p,char *res);
void constant();
struct expr
{
char op[2],op1[5],op2[5],res[5];
int flag;
}arr[10];
int n;
void main()
{
clrscr();
input();
constant();
output();
getch();
}
void input()
{
int i;
printf("\n\nEnter the maximum number of expressions : ");
scanf("%d",&n);
printf("\n\nEnter the input : \n");
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
for(i=0;i<n;i++)
{
scanf("%s",arr[i].op);
scanf("%s",arr[i].op1);
scanf("%s",arr[i].op2);
scanf("%s",arr[i].res);
arr[i].flag=0;
}
}
void constant()
{
int i;
int op1,op2,res;
char op,res1[5];
for(i=0;i<n;i++)
{
if(isdigit(arr[i].op1[0]) && isdigit(arr[i].op2[0]) || strcmp(arr[i].op,"")==0) /*if both digits,
store them in variables*/
{
op1=atoi(arr[i].op1);
op2=atoi(arr[i].op2);
op=arr[i].op[0];
switch(op)
{
case '+':
res=op1+op2;
break;
case '-':
res=op1-op2;
break;
case '*':
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
res=op1*op2;
break;
case '/':
res=op1/op2;
break;
case '=':
res=op1;
break;
}
sprintf(res1,"%d",res);
arr[i].flag=1; /*eliminate expr and replace any operand below that uses result of this expr */
change(i,res1);
}
}
}
void output()
{
int i=0;
printf("\nOptimized code is : ");
for(i=0;i<n;i++)
{
if(!arr[i].flag)
{
printf("\n%s %s %s %s",arr[i].op,arr[i].op1,arr[i].op2,arr[i].res);
}
}
}
void change(int p,char *res)
{
int i;
for(i=p+1;i<n;i++)
```




Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
{  
if(strcmp(arr[p].res,arr[i].op1)==0)  
strcpy(arr[i].op1,res);  
else if(strcmp(arr[p].res,arr[i].op2)==0)  
strcpy(arr[i].op2,res);  
}  
}
```

OUTPUT:

```
Enter the maximum number of expressions : 4
```

```
Enter the input :
```

```
= 3 - a
```

```
+ a b t1
```

```
+ a c t2
```

```
+ t1 t2 t3
```

```
Optimized code is :
```

```
+ 3 b t1
```

```
+ 3 c t2
```



Govt. Model Engineering College, Thrikkakara

Managed by Institute of Human Resources Development

A Govt. of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

18. Implement Intermediate code generation for simple expressions.

Program

```
#include <stdio.h>
#include <string.h>
void gen_code_for_operator(char *inp, char operator, char * reg)
{
    int i = 0, j = 0; // j is used as an index of temp, i is used as an index of inp
    char temp[100];
    while (inp[i] != '\0')
    {
        if (inp[i] == operator)
        {
            printf("%c\t%c\t%c\t%c\n", operator, *reg, inp[i - 1], inp[i + 1]);
            temp[j - 1] = *reg; // Instead of copying a/b to the temp string, copy
the output register Z
            i += 2;
            (*reg)--; // Change register from Z to Y etc
            continue;
        }
        temp[j] = inp[i];
        i++;
        j++;
    }
    temp[++j] = '\0';
    strcpy(inp, temp);
}
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
void gen_code(char *inp)
{
    // Operator precedence - /, *, +, -, =
    char reg = 'Z'; // Decrement to get Z, Y etc
    gen_code_for_operator(inp, '/', &reg);
    gen_code_for_operator(inp, '*', &reg);
    gen_code_for_operator(inp, '+', &reg);
    gen_code_for_operator(inp, '-', &reg);
    gen_code_for_operator(inp, '=', &reg);
}

int main()
{
    char inp[100];
    printf("Enter expression:\n\n");
    scanf("%s", inp);
    printf("Oprtr\tDestn\tOp1\tOp2\n");
    gen_code(inp);
}
```

Output

```
mec@cl1-3-1: ~/Documents/CSB
File Edit View Search Terminal Help
mec@cl1-3-1:~/Documents/CSB$ gcc 10_4.1_PROGRAM.c
mec@cl1-3-1:~/Documents/CSB$ ./a.out
Enter expression:
q=a+b-c/d*2
Oprtr  Destn  Op1  Op2
/      Z      c    d
*      Y      Z    2
+      X      a    b
-      W      X    Y
=      V      q    W
mec@cl1-3-1:~/Documents/CSB$
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

19. Implement the back end of the compiler which takes the three address code and produces the 8086 assembly language instructions that can be assembled and run using an 8086 assembler. The target assembly instructions can be simple move, add, sub, jump etc

Program

```
#include <stdio.h>
#include <stdio.h>
//#include <conio.h>
#include <string.h>
void main()
{
    char icode[10][30], str[20], opr[10];
    int i = 0;
    //clrscr();
    printf("\n Enter the set of intermediate code (terminated by exit) :\n ");
    do
    {
        scanf("%s", icode[i]);
    } while (strcmp(icode[i++], "exit") != 0);
    printf("\n target code generation");
    printf("\n*****");
    i = 0;
```



Govt.Model Engineering College,Thrikkakara

Managed by Institute of Human Resources Development

A Govt.of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

```
do
{
    strcpy(str, icode[i]);
    switch (str[3])
    {
        case '+':
            strcpy(opr, "ADD");
            break;
        case '-':
            strcpy(opr, "SUB");
            break;
        case '*':
            strcpy(opr, "MUL");
            break;
        case '/':
            strcpy(opr, "DIV");
            break;
    }
    printf("\n\tMov %c,R%d", str[2], i);
    printf("\n\t%s%c,R%d", opr, str[4], i);
    printf("\n\tMov R%d,%c", i, str[0]);
} while (strcmp(icode[++i], "exit") != 0);
//getch();
}
```



Govt. Model Engineering College, Thrikkakara

Managed by Institute of Human Resources Development

A Govt. of Kerala Establishment

Department of Computer Engineering

B.Tech in Computer Science and Engineering

Output

```
mec@cl1-3-1: ~/Documents/CSB
File Edit View Search Terminal Help
mec@cl1-3-1:~/Documents/CSB$ gcc 10_4.2_PROGRAM.c
mec@cl1-3-1:~/Documents/CSB$ ./a.out

Enter the set of intermediate code (terminated by exit) :
a=a*b
c=f*h
g=a*h
f=Q+w
t=q-j
exit

target code generation
*****
      Mov a,R0
      MULb,R0
      Mov R0,a
      Mov f,R1
      MULh,R1
      Mov R1,c
      Mov a,R2
      MULh,R2
      Mov R2,g
      Mov Q,R3
      ADDw,R3
      Mov R3,f
      Mov q,R4
      SUBj,R4
mec@cl1-3-1:~/Documents/CSB$
```