

15th
Edition

YASHAVANT KANETKAR'S

SOLUTIONS

Let Us
C

AUTHENTIC Solutions Of
Let Us C Exercises



BPB PUBLICATIONS

Let Us C Solutions

15th Edition

Yashavant Kanetkar



BPB PUBLICATIONS

Revised and Updated 2017 Edition

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*Dedicated to
Nalinee and Prabhakar Kanetkar*

About the Author

Through his books and Quest Video Courseware DVDs on C, C++, Data Structures, VC++, .NET, Embedded Systems, etc. Yashavant Kanetkar has created, moulded and groomed lacs of IT careers in the last two decades. Yashavant's books and Quest DVDs have made a significant contribution in creating top-notch IT manpower in India and abroad.

Yashavant's books are globally recognized and millions of students / professionals have benefitted from them. Yashavant's books have been translated into Hindi, Gujarati, Japanese, Korean and Chinese languages. Many of his books are published in India, USA, Japan, Singapore, Korea and China.

Yashavant is a much sought after speaker in the IT field and has conducted seminars/workshops at TedEx, IITs, RECs and global software companies.

Yashavant has recently been honored with the prestigious "Distinguished Alumnus Award" by IIT Kanpur for his entrepreneurial, professional and academic excellence. This award was given to top 50 alumni of IIT Kanpur who have made significant contribution towards their profession and betterment of society in the last 50 years.

In recognition of his immense contribution to IT education in India, he has been awarded the "Best .NET Technical Contributor" and "Most Valuable Professional" awards by Microsoft for 5 successive years.

Yashavant holds a BE from VJTI Mumbai and M.Tech. from IIT Kanpur.

Introduction

The first requests for a book like ‘Let Us C Solutions’ started coming when the third edition of Let Us C was released. I answered it by writing this book. Since then I have met so many readers who said that every new edition of Let Us C should be accompanied with two books—a new edition of ‘Let Us C Solutions’ and a new edition of “Let Us C Workbook”. I decided to accede to this request and from fifth edition onwards started releasing all these three books simultaneously.

The success of last nine editions of this book has validated my belief that if you have a book which lets a reader cross-check the solutions/programs that he creates, then it boosts his confidence and improves the overall language learning process.

If one has to understand C programming in its true perspective, then in my opinion one needs to make use of the communication revolution that has taken place around us. Using it, I have video-recorded all the aspects of C programming in the form of a solid 60-lecture course on a DVD. Using this DVD you will be able to directly learn C programming from me at your home.

Through all the editions of this book one person who never got tired of helping me was Manish Jain of BPB. No matter what request I made, he always acceded to it.

Amol Tambat, Ajay Daga, Prachi Garaye, Amit Mendhe, Vikrant Sahoo and Shoeb Parvez and Monali Nikhare were instrumental in checking all the solutions of several editions of this book. Many thanks to all of them! I have added many new exercises to Let Us C 15th edition. The solutions to all these exercises have been included in this edition of Let Us C Solutions.

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CHAPTER

ZERO

Before We Begin...

To understand C language and gain confidence in working with it you would be required to type programs in this book and then instruct the machine to execute them. To type any programs you need another program called Editor. Once the program has been typed it needs to be converted to machine language (0s and 1s) before the machine can execute it. To carry out this conversion, we need another program called Compiler. Compiler vendors provide an Integrated Development Environment (IDE) that consists of an Editor as well as the Compiler.

There are several such IDEs available in the market targeted towards different operating systems. For example, Turbo C and Turbo C++ are popular compilers that work under MS-DOS, Visual Studio and Visual Studio Express Edition are the compilers that work under Windows, whereas gcc compiler works under Linux. Note that Turbo C, Turbo C++ and gcc compilers can also be installed on machines running Windows OS.

Of these, Visual Studio Express Edition and gcc compilers are available free of cost. They can be downloaded from the following sites respectively:

<http://www.microsoft.com/express/Downloads/>
<http://www.cygwin.com>

Cygwin software provides you Linux like functionality under Windows. It comes with the gcc compiler. Once Cygwin is installed you need to download and install NetBeans for Windows from

<https://www.netbeans.org>

NetBeans merely provides the GUI. Internally it uses the gcc compiler that you downloaded with Cygwin.

If you wish to create programs under Linux then you can use the gecko compiler that comes with Linux and then install the Linux version of NetBeans.

You are free to use any of the compilers mentioned above for compiling programs in this book. If you wish to know my personal choice, I would prefer gcc with NetBeans or Visual Studio Express for a simple reason—it is a modern compiler with easy to use GUI (through NetBeans) is available free of cost.

Detailed Compilation Steps

The compilation process with each of the compilers mentioned in the previous section is a bit different. So for your benefit I am giving below the detailed compilation and execution steps with each of these compilers.

Compilation using TC / TC++

Here are the steps that you need to follow to compile and execute programs using TC/TC++...

- (a) Start the compiler at **C>** prompt. The compiler (TC.EXE) is usually present in **C:\TC\BIN** directory.

- (b) Select **New** from the **File** menu.
- (c) Type the program.
- (d) Save the program using **F2** under a proper name (say Program1.c).
- (e) Use **Ctrl + F9** to compile and execute the program.
- (f) Use **Alt + F5** to view the output.

A word of caution! If you run this program in Turbo C++ compiler, you may get an error—"The function printf should have a prototype". To get rid of this error, perform the following steps and then recompile the program.

- (a) Select 'Options' menu and then select 'Compiler | C++ Options'. In the dialog box that pops up, select 'CPP always' in the 'Use C++ Compiler' options.
- (b) Again select 'Options' menu and then select 'Environment | Editor'. Make sure that the default extension is 'C' rather than 'CPP'.

The installation procedure of TC compiler is very simple. However, if you install TC compiler under Windows Vista or Windows 7, the window size becomes very small. So small is the screen size that you can hardly work with it. You can increase the size of TC window to occupy the entire screen. For this you will have to download an x86 emulator called DosBox from following link:

<http://sourceforge.net/projects/dosbox/files/dosbox/0.74/DOSBox0.74-win32-installer.exe/download>

Once you have downloaded this emulator carry out the following steps:

- (a) Install the DosBox software that you have downloaded.
- (b) Create a folder called Turbo on your C: drive.
- (c) Copy entire Turbo C / Turbo C++ software in this Turbo folder.
- (d) Start DosBox by double clicking DosBox icon.
- (e) You would be presented with two screens. You need to use the one which has a `Z>` prompt in it. Type the following command at `Z>` prompt.

```
mount X C:\Turbo
mount D C:\Turbo\TC
D:
cd Bin
TC
```

By typing the last command "TC" you are executing the Turbo C / Turbo C++ software. This would bring up the normal blue colored TC window. To increase the window size just press Alt + Enter. Now the TC window will accommodate the entire screen.

- (f) Go to the Options Menu (Alt O), select 'Directories' menu item and change the 'Include' and 'Library' directory such that they contain the following entries:

```
X:\TC\INCLUDE
X:\TC\LIB
```

- (g) Once you have typed and saved program do not compile it using the usual Ctrl F9. Instead, compile it using the Compile Menu and execute it using Run Menu.

Compilation using gecko plus NetBeans

Carry out the following steps to compile and execute programs using gcc and any NetBeans version:

- (a) Start NetBeans from Start | All Programs | NetBeans.
- (b) Select File | New Project... from the File menu. Select Project Category as C/C++ and Project Type as C/C++ Application from the dialog that pops up. Click Next button.
- (c) Give a proper name of the project in Project Name TextBox (say Program1). Then click Finish.
- (d) Type the program.
- (e) Save the program using **Ctrl + S**.
- (f) Use **F6** to compile and execute the program.

Compilation using Visual Studio / Visual Studio Express Edition

Carry out the following steps to compile and execute programs using any Visual Studio version:

- (a) Start Visual Studio from Start | All Programs | Microsoft Visual Studio or start Visual Studio Express Edition from Start | All Programs | Microsoft Visual C++ Express Edition.
- (b) Select File | New Project... from the File menu. Select Project Type as Visual C++ | Win32 Console Application (or Visual C++ | CLR Console Application) from the dialog that pops up. Give a proper name of the project in Name TextBox (say Program1). Then click on OK and Finish.
- (c) Type the program.

- (d) Save the program using **Ctrl + S**.
- (e) Use **Ctrl + F5** to compile and execute the program.

When you use Visual Studio to create a Win32 Console Application for the above program the wizard would insert the following code by default:

```
#include "stdafx.h"
int _tmain ( int argc, _TCHAR* argv[ ] )
{
    return 0 ;
}
```

You can delete this code and type your program in its place. If you now compile the program using Ctrl F5 you would get the following error:

Fatal error C1010:
unexpected end of file while looking for precompiled header.
Did you forget to add '#include "stdafx.h"' to your source?

If you add #include "stdafx.h" at the top of your program then it would compile and run successfully. However, including this file makes the program Visual Studio-centric and would not get compiled with TC / TC++ or NetBeans compilers. This is not good as the program no longer remains portable. To eliminate this error, you need to make a setting in Visual Studio by carrying out the following steps:

- (a) Go to 'Solution Explorer' window in your project.
- (b) Right click on the project name and select 'Properties' from the menu that pops up. On doing so, a dialog shown in Figure 0.1 would appear.

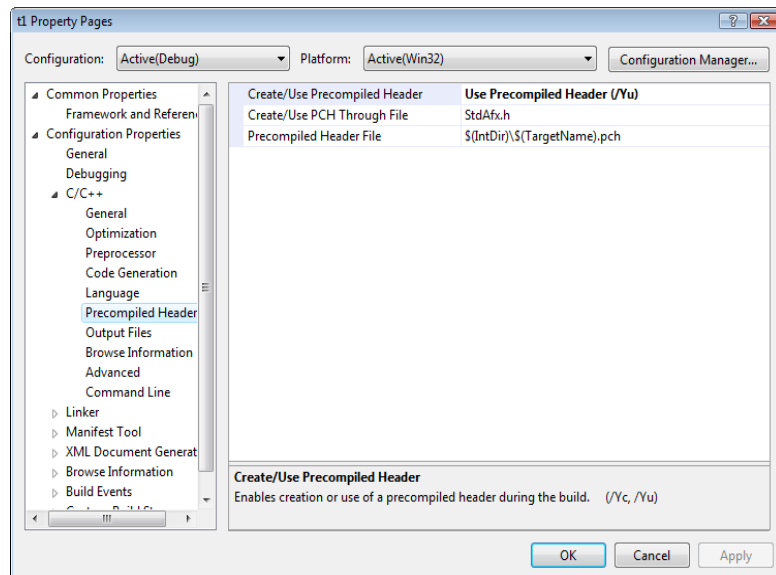


Figure 0.1

- (c) From the left pane of this dialog first select 'Configuration Properties' followed by 'C/C++'.
- (d) Select 'Precompiled Headers'
- (e) From the right pane of the dialog click on 'Create/Use Precompiled Header'. On doing so in the value for this option a triangle would appear.
- (f) Click on this triangle and a drop down list box would appear.
- (g) From the list box select 'Not using Precompiled Header'.
- (h) Click on OK button to make the setting effective.

In addition to this, you need to make one more setting. By default Visual Studio believes that your program is a C++ program and

not a C program. So by making a setting you need to tell it that your program is a C program and not a C++ program. Carry out the following steps to make this setting:

- (a) Go to 'Solution Explorer' window.
- (b) Right click on the project name and select 'Properties' from the menu that pops up. On doing so, a dialog shown in Figure 0.2 would appear.

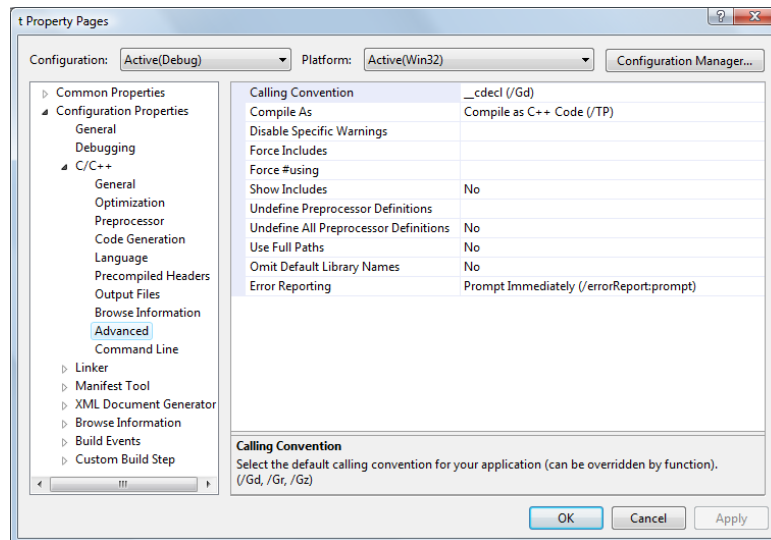


Figure 0.2

- (c) From the left pane of this dialog first select 'Configuration Properties' followed by 'C/C++'.
- (d) In C/C++ options select 'Advanced'.
- (e) Change the 'Compile As' option to 'Compile as C code (/TC)'.

Once this setting is made you can now compile the program using Ctrl F5. This time no error would be flagged and the program would compile and execute successfully.

A Word of Caution

All programs given in the chapters to follow have been created assuming that you have installed VisualStudio on your machine. If you have installed TC / TC++, then you would be required to make some minor changes pertaining to clearing of screen and positioning of cursor. Let me show this to you using a simple program that first clears the screen then positions the cursor at 10th row, 20th column and prints a message at this location. . If we were to use Visual Studio, the program would look like this...

```
#include <stdio.h>
#include <system.h>
void gotoxy ( short int col, short int row );

int main( )
{
    system ( "cls" ); /* clear existing contents on screen */
    gotoxy ( 20, 10 ); /* position cursor */
    printf ( "Hello" );
}

void gotoxy ( short int col, short int row )
{
    HANDLE hStdout = GetStdHandle ( STD_OUTPUT_HANDLE );
    COORD position = { col, row };
    SetConsoleCursorPosition ( hStdout, position );
}
```

A similar program in Turbo C / C++ would take the following form:

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

```
int main( )
{
    clrscr( ) ; /* clear existing contents on screen */
    gotoxy ( 20, 10 ) ; /* position cursor */
    printf ( "Hello" ) ;
}
```

So if you are using Turbo C / Turbo C++ compiler then you will have to make the changes shown above to make the programs work.

CHAPTER ONE

Getting Started

[A] Which of the following are invalid C constants and why?

'3.15'	Invalid. A character constant can contain only 1 character
35,550	Invalid. An integer constant cannot contain a comma
3.25e2	Valid
2e-3	Valid
'eLearning'	Invalid. A character constant can contain only 1 character
"show"	Invalid. A character constant can contain only 1 character
'Quest'	Invalid. A character constant can contain only 1 character
23	Valid
4 6 5 2	Invalid. There cannot be a space within a constant

[B] Which of the following are invalid variable names and why?

B'day	Invalid. A '' is not allowed in
-------	---------------------------------

	variable name
int	Invalid. Keyword cannot be used as a variable name
\$hello	Invalid. Variable name must begin with an alphabet or underscore
#HASH	Invalid. Variable name must begin with an alphabet or underscore
dot.	Invalid. A '.' is not allowed in variable name
number	Valid
totalArea	Valid
_main()	Valid
temp_in_Deg	Valid
total%	Invalid. A '%' is not allowed in variable name
1 st	Invalid. A variable name must start with an alphabet or an underscore
stack-queue	Invalid. We cannot use hyphen in variable name
variable name	Invalid. Variable name cannot contain spaces
%name%	Invalid. A variable name must start with an alphabet or an underscore
salary	Valid

[C] State whether the following statements are True or False:

- (a) C language has been developed by Dennis Ritchie.

Answer: True

- (b) Operating systems like Windows, Unix, Linux and Android are written in C.

Answer: True

- (c) C language programs can easily interact with hardware of a PC / Laptop.

Answer: True

- (d) A real constant in C can be expressed in both Fractional and Exponential forms

Answer: True

- (e) A character variable can at a time store only one character.

Answer: True

- (f) The maximum value that an integer constant can have varies from one compiler to another.

Answer: True

- (g) Usually all C statements are entered in small case letters.

Answer: True

- (h) Spaces may be inserted between two words in a C statement.

Answer: True

- (i) Spaces cannot be present within a variable name.

Answer: True

- (j) C programs are converted into machine language with the help of a program called Editor.

Answer: False

- (k) Most development environments provide an Editor to type a C program and a Compiler to convert it into machine language.

Answer: True

- (l) **int**, **char**, **float**, **real**, **integer**, **character**, **char**, **main**, **printf** and **scanf** all are keywords.

Answer: False

[D] Match the following:

- | | |
|-----------------------------|----------------------|
| (a) <code>\n</code> | Escape sequence |
| (b) 3.145 | Real constant |
| (c) -6513 | Integer constant |
| (d) 'D' | Character constant |
| (e) 4.25e-3 | Exponential form |
| (f) <code>main()</code> | Function |
| (g) <code>%f, %d, %c</code> | Format specifier |
| (h) <code>;</code> | Statement terminator |
| (i) Constant | Literal |
| (j) Variable | Identifier |
| (k) <code>&</code> | Address of operator |
| (l) <code>printf()</code> | Output function |
| (m) <code>scanf()</code> | Input function |

[E] Point out the errors, if any, in the following programs:

- (a)

```
int main( )
{
    int a, float b, int c ;
    a = 25 ; b = 3.24 ; c = a + b * b - 35 ;
}
```

No error. Multiple C statements can be written in a single line.

```
(b) /* Calculation of average
      /* Author: Sanjay */
      /* Place – Whispering Bytes */
      */

#include <stdio.h>
int main( )
{
    int a = 35 ; float b = 3.24 ;
    printf ( "%d %f %d", a, b + 1.5, 235 ) ;
}
```

No error. The list being printed in **printf()** may contain variables, constants or expressions.

```
(c) #include <stdio.h>
int main( )
{
    int a, b, c ;
    scanf ( "%d %d %d", a, b, c ) ;
}
```

Error. We should use & before each variable used in **scanf()**.

```
(d) #include <stdio.h>
int main( )
{
    int m1, m2, m3
    printf ( "Enter values of marks in 3 subjects" )
    scanf ( "%d %d %d", &m1, &m2, &m3 )
    printf ( "You entered %d %d %d", m1, m2, m3 ) ;
}
```

Error. Semicolon should be present at the end of type declaration, **printf()** and **scanf()** statements.

[F] Attempt the following:

- (a) Ramesh's basic salary is input through the keyboard. His dearness allowance is 40% of basic salary, and house rent allowance is 20% of basic salary. Write a program to calculate his gross salary.

Program:

```
/* Calculate Ramesh's gross salary */
#include <stdio.h>
int main( )
{
    float bp, da, hra, grpay ;

    printf ( "\nEnter Basic Salary of Ramesh: " ) ;
    scanf ( "%f", &bp ) ;

    da = 0.4 * bp ;
    hra = 0.2 * bp ;
    grpay = bp + da + hra ; /* Gross Pay = sum of basic &
                           all allowances */

    printf ( "Basic Salary of Ramesh = %f\n", bp ) ;
    printf ( "Dearness Allowance = %f\n", da ) ;
    printf ( "House Rent Allowance = %f\n", hra ) ;
    printf ( "Gross Pay of Ramesh is %f\n", grpay ) ;

    return 0 ;
}
```

- (b) The distance between two cities (in km.) is input through the keyboard. Write a program to convert and print this distance in meters, feet, inches and centimeters.

Program:

```
/* Conversion of distance */
#include <stdio.h>
int main( )
{
    float km, m , cm, ft, inch ;

    printf ( "\nEnter the distance in Kilometers: " );
    scanf ( "%f", &km );

    m = km * 1000 ;
    cm = m * 100 ;
    inch = cm / 2.54 ;
    ft = inch / 12 ;

    printf ( "Distance in meters = %f\n", m );
    printf ( "Distance in centimeter = %f\n", cm );
    printf ( "Distance in feet = %f\n", ft );
    printf ( "Distance in inches = %f\n", inch );

    return 0 ;
}
```

- (c) If the marks obtained by a student in five different subjects are input through the keyboard, write a program to find out the aggregate marks and percentage marks obtained by the student. Assume that the maximum marks that can be obtained by a student in each subject is 100.

Program:

```
/* Calculation of aggregate & percentage marks */
#include <stdio.h>
int main( )
{
    int m1, m2, m3, m4, m5, aggr ;
    float per ;
```

```
printf ( "\nEnter marks in 5 subjects: " );
scanf ( "%d %d %d %d %d", &m1, &m2, &m3, &m4, &m5 );

aggr = m1 + m2 + m3 + m4 + m5 ;
per = aggr / 5 ;

printf ( "Aggregate Marks = %d\n", aggr ) ;
printf ( "Percentage Marks = %f\n", per ) ;

return 0 ;
}
```

- (d) Temperature of a city in Fahrenheit degrees is input through the keyboard. Write a program to convert this temperature into Centigrade degrees.

Program:

```
/* Conversion of temperature from Fahrenheit to Centigrade */
#include <stdio.h>
int main( )
{
    float fr, cent ;

    printf ( "\nEnter the temperature (F): " );
    scanf ( "%f", &fr ) ;

    cent = 5.0 / 9.0 * ( fr - 32 ) ;
    printf ( "Temperature in centigrade = %f\n", cent ) ;

    return 0 ;
}
```

- (e) The length & breadth of a rectangle and radius of a circle are input through the keyboard. Write a program to calculate the area & perimeter of the rectangle, and the area & circumference of the circle.

Program:

```
/* Calculation of perimeter & area of rectangle and circle */
#include <stdio.h>
int main( )
{
    int l, b, r, area1, perimeter ;
    float area2, circum ;

    printf ( "\nEnter Length & Breadth of Rectangle: " ) ;
    scanf ( "%d %d", &l, &b ) ;
    area1 = l * b ; /* Area of a rectangle */
    perimeter = 2 * l + 2 * b ; /* Perimeter of a rectangle */

    printf ( "Area of Rectangle = %d\n", area1 ) ;
    printf ( "Perimeter of Rectangle = %d\n", perimeter ) ;

    printf ( "\n\nEnter Radius of circle: " ) ;
    scanf ( "%d", &r ) ;

    area2 = 3.14 * r * r ; /* Area of Circle */
    circum = 2 * 3.14 * r ; /* Circumference of a circle */

    printf ( "Area of Circle = %f\n", area2 ) ;
    printf ( "Circumference of Circle = %f\n", circum ) ;

    return 0 ;
}
```

- (f) Paper of size A0 has dimensions 1189 mm x 841 mm. Each subsequent size A(n) is defined as A(n-1) cut in half parallel to its shorter sides. Write a program to calculate and print paper sizes A0, A1, A2, ... A8.

Program:

```
/* Calculation of PaperSizes A0 to A8 */
```

```
# include <stdio.h>

int main( )
{
    int a0ht, a0wd ;
    int a1ht, a1wd, a2ht, a2wd ;
    int a3ht, a3wd, a4ht, a4wd ;
    int a5ht, a5wd, a6ht, a6wd ;
    int a7ht, a7wd, a8ht, a8wd ;

    a0ht = 1189 ;
    a0wd = 841 ;
    printf ( "Size of A0 paper Height = %d Width = %d\n", a0ht, a0wd ) ;

    a1ht = a0wd ;
    a1wd = a0ht / 2 ;
    printf ( "Size of A1 paper Height = %d Width = %d\n", a1ht, a1wd ) ;

    a2ht = a1wd ;
    a2wd = a1ht / 2 ;
    printf ( "Size of A2 paper Height = %d Width = %d\n", a2ht, a2wd ) ;

    a3ht = a2wd ;
    a3wd = a2ht / 2 ;
    printf ( "Size of A3 paper Height = %d Width = %d\n", a3ht, a3wd ) ;

    a4ht = a3wd ;
    a4wd = a3ht / 2 ;
    printf ( "Size of A4 paper Height = %d Width = %d\n", a4ht, a4wd ) ;

    a5ht = a4wd ;
    a5wd = a4ht / 2 ;
    printf ( "Size of A5 paper Height = %d Width = %d\n", a5ht, a5wd ) ;

    a6ht = a5wd ;
    a6wd = a5ht / 2 ;
    printf ( "Size of A6 paper Height = %d Width = %d\n", a6ht, a6wd ) ;
```

```
a7ht = a6wd ;  
a7wd = a6ht / 2 ;  
printf ( "Size of A7 paper Height = %d Width = %d\n", a7ht, a7wd ) ;  
  
a8ht = a7wd ;  
a8wd = a7ht / 2 ;  
printf ( "Size of A8 paper Height = %d Width = %d\n", a8ht, a8wd ) ;  
  
return 0 ;  
}
```


CHAPTER

TWO

C Instructions

[A] Point out the errors, if any, in the following C statements:

(a) `x = (y + 3) ;`

No error.

(b) `cir = 2 * 3.141593 * r ;`

No error.

(c) `char = '3' ;`

Error. Keyword cannot be used as a variable name.

(d) `4 / 3 * 3.14 * r * r * r = vol_of_sphere ;`

Error. On the left-hand side of equal to (=) there can only be a variable.

(e) `volume = a3 ;`

Error. a^3 is not a valid statement. Instead we can use `a * a * a`.

(f) `area = 1 / 2 * base * height ;`

No error.

(g) `si = p * r * n / 100 ;`

No error.

(h) `area of circle = 3.14 * r * r ;`

Error. **area of circle** is an invalid variable name.

(i) `peri_of_tri = a + b + c ;`

No error.

(j) `slope = (y2 - y1) ÷ (x2 - x1) ;`

Error. '÷' is an invalid operator.

(k) `3 = b = 4 = a ;`

Error. A variable name must be present on the left hand side of '=' operator.

(l) `count = count + 1 ;`

No error.

(m) `char ch = '25 Apr 12' ;`

Error. Multiple characters cannot be stored in a char variable.

[B] Evaluate the following expressions and show their hierarchy.

(a) `ans = 5 * b * b * x - 3 * a * y * y - 8 * b * b * x + 10 * a * y ;`

(a = 3, b = 2, x = 5, y = 4 assume **ans** to be a int)

Answer:

<code>ans = 5 * 2 * 2 * 5 - 3 * 3 * 4 * 4 - 8 * 2 * 2 * 5 + 10 * 3 * 4</code>	operation: *
<code>ans = 10 * 2 * 5 - 3 * 3 * 4 * 4 - 8 * 2 * 2 * 5 + 10 * 3 * 4</code>	operation: *
<code>ans = 20 * 5 - 3 * 3 * 4 * 4 - 8 * 2 * 2 * 5 + 10 * 3 * 4</code>	operation: *
<code>ans = 100 - 3 * 3 * 4 * 4 - 8 * 2 * 2 * 5 + 10 * 3 * 4</code>	operation: *
<code>ans = 100 - 9 * 4 * 4 - 8 * 2 * 2 * 5 + 10 * 3 * 4</code>	operation: *
<code>ans = 100 - 36 * 4 - 8 * 2 * 2 * 5 + 10 * 3 * 4</code>	operation: *
<code>ans = 100 - 144 - 8 * 2 * 2 * 5 + 10 * 3 * 4</code>	operation: *
<code>ans = 100 - 144 - 16 * 2 * 5 + 10 * 3 * 4</code>	operation: *
<code>ans = 100 - 144 - 32 * 5 + 10 * 3 * 4</code>	operation: *
<code>ans = 100 - 144 - 160 + 10 * 3 * 4</code>	operation: *
<code>ans = 100 - 144 - 160 + 30 * 4</code>	operation: *
<code>ans = 100 - 144 - 160 + 120</code>	operation: -

ans = **-44** - 160 + 120
 ans = **-204** + 120
 ans = -84

operation: -
 operation: +

(b) res = 4 * a * y / c - a * y / c ;

(a = 4, y = 1, c = 3, assume **res** to be an int)

Answer:

res = **4 * 4** * 1 / 3 - 4 * 1 / 3
 res = **16 * 1** / 3 - 4 * 1 / 3
 res = **16 / 3** - 4 * 1 / 3
 res = **5 - 4** * 1 / 3
 res = **5 - 4** / 3
 res = **5 - 1**
 res = 4

operation: *
 operation: *
 operation: /
 operation: *
 operation: /
 operation: -

(c) s = c + a * y * y / b ;

(a = 2.2, b = 0.0, c = 4.1, y = 3.0, assume **s** to be a float)

Answer:

s = 4.1 + **2.2 * 3.0** * 3.0 / 0.0
 s = 4.1 + **6.6 * 3.0** / 0.0
 s = 4.1 + **19.8 / 0.0**
 Here we cannot Divide by 0

operation: *
 operation: *
 operation: /

(d) R = x * x + 2 * x + 1 / 2 * x * x + x + 1 ;

(x = 3.5, assume **R** to be a float)

Answer:

R = **3.5 * 3.5** + 2 * 3.5 + 1 / 2 * 3.5 * 3.5 + 3.5 + 1
 R = 12.25 + **2 * 3.5** + 1 / 2 * 3.5 * 3.5 + 3.5 + 1
 R = 12.25 + 7.0 + 1 / **2 * 3.5** * 3.5 + 3.5 + 1
 R = 12.25 + 7.0 + 1 / **7.0 * 3.5** + 3.5 + 1
 R = 12.25 + 7.0 + **1 / 24.5** + 3.5 + 1

operation: *
 operation: *
 operation: *
 operation: *
 operation: /

$R = 12.25 + 7.0 + 0.04081 + 3.5 + 1$	operation: +
$R = 19.25 + 0.04081 + 3.5 + 1$	operation: +
$R = 19.29081 + 3.5 + 1$	operation: +
$R = 22.79081 + 1$	operation: +
$S = 23.79081$	

[C] Indicate the order in which the following expressions would be evaluated.

(a) $g = 10 / 5 / 2 / 1 ;$

Evaluation order would be:

$g = 10 / 5 / 2 / 1 ;$	operation: /
$g = 2 / 2 / 1 ;$	operation: /
$g = 1 / 1 ;$	operation: /
$g = 1 ;$	operation: =

(b) $b = 3 / 2 + 5 * 4 / 3 ;$

Evaluation order would be:

$b = 3 / 2 + 5 * 4 / 3$	operation: /
$b = 1 + 5 * 4 / 3$	operation: *
$b = 1 + 20 / 3$	operation: /
$b = 1 + 6$	operation: +
$b = 7$	operation: =

(c) $a = b = c = 3 + 4 ;$

Evaluation order would be:

$a = b = c = 3 + 4$	operation: +
$a = b = c = 7$	operation: =
$a = b = 7$	operation: =
$a = 7$	operation: =

(d) $x = 2 - 3 + 5 * 2 / 8 \% 3 ;$

Evaluation order would be:

$x = 2 - 3 + 5 * 2 / 8 \% 3$	operation: *
------------------------------	--------------

$x = 2 - 3 + 10 / 8 \% 3$	operation: /
$x = 2 - 3 + 1 \% 3$	operation: %
$x = 2 - 3 + 1$	operation: -
$x = -1 + 1$	operation: +
$x = 0$	operation: =

(e) $z = 5 \% 3 / 8 * 3 + 4 ;$

Evaluation order would be:

$z = 5 \% 3 / 8 * 3 + 4$	operation: %
$z = 2 / 8 * 3 + 4$	operation: /
$z = 0 * 3 + 4$	operation: *
$z = 0 + 4$	operation: +
$z = 4$	operation: =

(f) $y = z = -3 \% -8 / 2 + 7 ;$

Evaluation order would be:

$y = z = -3 \% -8 / 2 + 7$	operation: -
$y = z = -3 \% -8 / 2 + 7$	operation: -
$y = z = -3 \% -8 / 2 + 7$	operation: %
$y = z = -3 / 2 + 7$	operation: /
$y = z = -1 + 7$	operation: +
$y = z = 6$	operation: =
$y = 6$	operation: =

[D] Convert the following algebraic expressions into equivalent C statements.

(a)
$$Z = \frac{(x+3)x^3}{(y-4)(y+5)}$$

Answer:

$$Z = ((x+3) * x * x * x) / ((y-4) * (y+5))$$

$$(b) \quad R = \frac{2v + 6.22 (c + d)}{g + v}$$

Answer:

$$R = (2 * v + 6.22 * (c + d)) / (g + v)$$

$$(c) \quad A = \frac{7.7b (xy + a) / c - 0.8 + 2b}{(x + a) (1 / y)}$$

Answer:

$$A = ((7.7 * b) * (x * y + a) / c - 0.8 + 2 * b) / ((x + a) * (1 / y))$$

$$(d) \quad X = \frac{12x^3}{4x} + \frac{8x^2}{4x} + \frac{x}{8x} + \frac{8}{8x}$$

Answer:

$$X = (12 * x * x * x / 4 * x) + (8 * x * x / 4 * x) + (x / 8 * x) + (8 / 8 * x)$$

[E] What will be the output of the following programs:

```
(a) #include <stdio.h>
int main( )
{
    int i = 2, j = 3, k, l;
    float a, b;
    k = i / j * j;
    l = j / i * i;
    a = i / j * j;
    b = j / i * i;
    printf ( "%d %d %f %f\n", k, l, a, b );
    return 0;
}
```

Output:

```
0 2 0.000000 2.000000
```

```
(b) #include <stdio.h>
int main( )
{
    int a, b, c, d ;
    a = 2 % 5 ;
    b = -2 % 5 ;
    c = 2 % -5 ;
    d = -2 % -5 ;
    printf ( "a = %d b = %d c = %d d = %d\n", a, b, c, d ) ;
    return 0 ;
}
```

Output:

```
a = 2 b = -2 c = 2 d = -2
```

```
(c) #include <stdio.h>
int main( )
{
    float a = 5, b = 2 ;
    int c, d ;
    c = a % b ;
    d = a / 2 ;
    printf ( "%d\n", d ) ;
    return 0 ;
}
```

Output:

Error. Mod (%) operator cannot be used on **floats**

```
(d) #include <stdio.h>
int main( )
{
    printf ( "\n\n\n\n\n" ) ;
    printf ( "\n\n/n/n\n/n" ) ;
    return 0 ;
}
```

```
}
```

Output:

```
nn
nn /n/n nn/n
```

```
(e) #include <stdio.h>
int main( )
{
    int a, b ;
    printf ( "Enter values of a and b" ) ;
    scanf ( " %d %d ", &a, &b ) ;
    printf ( "a = %d b = %d", a, b ) ;
    return 0 ;
}
```

Output:

Since spaces are given after and before double quotes in **scanf()** we must supply a space, then two numbers and again a space followed by enter. The **printf()** would then output the two number that you enter.

[F] State whether the following statements are True or False:

(a) * or /, + or – represents the correct hierarchy of arithmetic operators in C.

Answer: True

(b) [] and { } can be used in Arithmetic instructions.

Answer: False

(c) Hierarchy decides which operator is used first.

Answer: True

- (d) In C, Arithmetic instruction cannot contain constants on left side of =.

Answer: True

- (e) In C ** operator is used for exponentiation operation.

Answer: False

- (f) % operator cannot be used on floats.

Answer: True

[G] Fill in the blanks:

- (a) In $y = 10 * x / 2 + z$; $10 * x$ operation will be performed first.
- (b) If **a** is an integer variable, $a = 11 / 2$; will store 5 in **a**.
- (c) The expression, $a = 22 / 7 * 5 / 3$; would evaluate to 5.
- (d) The expression $x = -7 \% 2 - 8$ would evaluate to -9.
- (e) If **d** is a **float** the operation **d = 2 / 7.0** would store 0.285714 in **d**.

[H] Attempt the following:

- (a) If a five-digit number is input through the keyboard, write a program to calculate the sum of its digits. (Hint: Use the modulus operator '%')

Program:

```
/* Sum of digits of a 5 digit number */  
#include <stdio.h>
```



```
int main( )
{
    int num, a, n ;
    int sum = 0 ; /* initialise to zero, otherwise it will contain a
                    garbage value*/

    printf ( "\nEnter a 5 digit number(less than 32767): " ) ;
    scanf ( "%d", &num ) ;

    a = num % 10 ; /* last digit extracted as remainder */
    n = num /10 ; /* remaining digits */
    sum = sum + a ; /* sum updated with addition of extracted digit */

    a = n % 10 ; /* 4 th digit */
    n = n /10 ;
    sum = sum + a ;

    a = n % 10 ; /* 3 rd digit */
    n = n /10 ;
    sum = sum + a ;

    a = n % 10 ; /* 2 nd digit */
    n = n /10 ;
    sum = sum + a ;

    a = n % 10 ; /* 1 st digit */
    sum = sum + a ;

    printf ( "The sum of the 5 digits of %d is %d\n", num, sum ) ;

    return 0 ;
}
```

- (b) If a five-digit number is input through the keyboard, write a program to reverse the number.

Program:

```
/* Reverse digits of a 5-digit number */
#include <stdio.h>

int main( )
{
    int n, a, b ;
    long int revnum = 0 ;

    printf ( "\nEnter a five digit number (less than 32767): " ) ;
    scanf ( "%d", &n ) ;

    a = n % 10 ; /* last digit */
    n = n / 10 ; /* remaining digits */
    revnum = revnum + a * 10000L ; /* revnum updated with
                                   value of extracted digit */

    a = n % 10 ; /* 4 th digit */
    n = n / 10 ; /* remaining digits */
    revnum = revnum + a * 1000 ;

    a = n % 10 ; /* 3 rd digit */
    n = n / 10 ; /* remaining digits */
    revnum = revnum + a * 100 ;

    a = n % 10 ; /* 2 nd digit */
    n = n / 10 ; /* remaining digits */
    revnum = revnum + a * 10 ;

    a = n % 10 ; /* 1 st digit */
    revnum = revnum + a ;

    /* specifier %ld is used for printing a long integer */
    printf ( "The reversed number is %ld\n", revnum ) ;

    return 0 ;
}
```

- (c) If lengths of three sides of a triangle are input through the keyboard, write a program to find the area of the triangle.

Program:

```
/* Find area of a triangle, given its sides */
#include <stdio.h>
#include <math.h>

int main( )
{
    float a, b, c, sp, area ;

    printf ( "\nEnter sides of a triangle: " );
    scanf ( "%f %f %f", &a, &b, &c );

    sp = ( a + b + c ) / 2 ;
    area = sqrt ( sp * ( sp - a ) * ( sp - b ) * ( sp - c ) );
    printf ( "Area of triangle = %f\n", area );

    return 0 ;
}
```

- (d) Write a program to receive Cartesian co-ordinates (x, y) of a point and convert them into polar co-ordinates (r, ϕ).

Program:

```
/* Convert Cartesian co-ordinates to Polar co-ordinates */
#include <stdio.h>
#include <math.h>

int main( )
{
    float x, y, r, theta ;

    printf ( "\nEnter x and y co-ordinates: " );
```

```
scanf ( "%f %f", &x, &y ) ;

r = sqrt ( x * x + y * y ) ;
theta = atan2 ( y, x ) ;
theta = theta * 180 / 3.14 ; /* convert to degrees */
printf ( "r = %f theta = %f\n", r, theta ) ;

return 0 ;
}
```

- (e) Write a program to receive values of latitude (L1, L2) and longitude (G1, G2), in degrees, of two places on the earth and outputs the distance between them in nautical miles. The formula for distance in nautical miles is:

$$D = 3963 \cos (\sin L1 \sin L2 + \cos L1 \cos L2 * \cos (G2 - G1))$$

Program:

```
/* Calculate distance between two places in Nautical Miles */
# include <stdio.h>
# include <math.h>

int main( )
{
    float lat1, lat2, lon1, lon2, d ;

    printf ( "\nEnter Latitude and Longitude of Place 1: " ) ;
    scanf ( "%f %f", &lat1, &lon1 ) ;

    printf ( "Enter Latitude and Longitude of Place 2: " ) ;
    scanf ( "%f %f", &lat2, &lon2 ) ;

    lat1 = lat1 * 3.14 / 180 ;
    lat2 = lat2 * 3.14 / 180 ;
    lon1 = lon1 * 3.14 / 180 ;
    lon2 = lon2 * 3.14 / 180 ;
```

```

    d = 3963 * acos ( sin ( lat1 ) * sin ( lat2 ) + cos ( lat1 ) * cos ( lat2 )
        * cos ( lon2 - lon1 ) );
    printf ( "Distance between Place1 and Place 2: %f\n", d );

    return 0 ;
}

```

- (f) Wind chill factor is the felt air temperature on exposed skin due to wind. The wind chill temperature is always lower than the air temperature, and is calculated as per the following formula:

$$wcf = 35.74 + 0.6215t + (0.4275t - 35.75) * v^{0.16}$$

where t is the temperature and v is the wind velocity. Write a program to receive values of t and v and calculate wind chill factor.

Program:

```

/* Calculation of wind chill factor */
# include <stdio.h>
# include <math.h>

int main( )
{
    float temp, vel, wcf ;

    printf ( "\nEnter values of temp and velocity: " );
    scanf ( "%f %f", &temp, &vel );
    wcf = 35.74 + 0.6215 * temp + ( 0.4275 * t - 35.75 )
        * pow ( vel, 0.16f );

    printf ( "Wind Chill Factor = %f\n", wcf );

    return 0 ;
}

```

- (g) If value of an angle is input through the keyboard, write a program to print all its Trigonometric ratios.

```
/* Print all Trigonometric ratios of an angle */
# include <stdio.h>
# include <math.h>

int main( )
{
    float angle, s, c, t ;

    printf ( "\nEnter an angle: " ) ;
    scanf ( "%f", &angle ) ;

    /* convert angle to radians */
    angle = angle * 3.14 / 180 ;

    s = sin ( angle ) ;
    c = cos ( angle ) ;
    t = tan ( angle ) ;

    printf ( "sin = %f cos = %f tan = %f\n", s, c, t ) ;

    return 0 ;
}
```

- (h) Two numbers are input through the keyboard into two locations C and D. Write a program to interchange the contents of C and D.

Program:

```
/* Interchanging of contents of two variables c & d */
# include <stdio.h>

int main( )
{
    int c, d, e ;
```

```
printf ( "\nEnter the number at location C: " );
scanf ( "%d", &c );
printf ( "\nEnter the number at location D: " );
scanf ( "%d", &d );

/* Interchange contents of two variables using a third variable as
   temporary store */
e = c ;
c = d ;
d = e ;

printf ( "New Number at location C = %d\n", c );
printf ( "New Number at location D = %d\n", d );

return 0 ;
}
```

- (i) Consider a currency system in which there are notes of seven denominations, namely, Re. 1, Rs. 2, Rs. 5, Rs. 10, Rs. 50, Rs. 100. If a sum of Rs. N is entered through the keyboard, write a program to compute the smallest number of notes that will combine to give Rs. N.

Program:

```
/* Find smallest number of notes that will combine to give the amount */
#include <stdio.h>

int main( )
{
    int amount, nohun, nofifty, noten, nofive, notwo, noone, totalnotes ;

    printf ( "Enter the amount: " );
    scanf ( "%d", &amount );

    nohun = amount / 100 ;
```

```
amount = amount % 100 ;
nofifty = amount / 50 ;
amount = amount % 50 ;
noten = amount / 10 ;
amount = amount % 10 ;
nofive = amount / 5 ;
amount = amount % 5 ;
notwo = amount / 2 ;
amount = amount % 2 ;
noone = amount / 1 ;
amount = amount % 1 ;

totalnotes = nohun + nofifty + noten + nofive + notwo + noone ;

printf ( "Smallest number of notes = %d\n", totalnotes ) ;

return 0 ;
}
```


CHAPTER THREE

Decision Control Instruction

[A] What will be the output of the following programs:

(a)

```
#include <stdio.h>
int main( )
{
    int  a = 300, b, c ;
    if ( a >= 400 )
        b = 300 ;
    c = 200 ;
    printf ( "%d %d\n", b, c ) ;
    return 0 ;
}
```

Output:

b will contain some garbage value and **c** will be equal to 200

(b)

```
#include <stdio.h>
int main( )
{
    int  a = 500, b, c ;
    if ( a >= 400 )
        b = 300 ;
}
```

```
    c = 200 ;
    printf ( "%d %d\n", b, c ) ;
    return 0 ;
}
```

Output:

300 200

```
(c) #include <stdio.h>
int main( )
{
    int  x = 10, y = 20 ;
    if ( x == y ) ;
        printf ( "%d %d\n", x, y ) ;
    return 0 ;
}
```

Output:

10 20

```
(d) #include <stdio.h>
int main( )
{
    int  x = 3 ;
    float y = 3.0 ;
    if ( x == y )
        printf ( "x and y are equal\n" ) ;
    else
        printf ( "x and y are not equal\n" ) ;
    return 0 ;
}
```

Output:

x and y are equal

```
(e) #include <stdio.h>
```

```
int main( )
{
    int  x = 3, y, z ;
    y = x = 10 ;
    z = x < 10 ;
    printf ( "x = %d y = %d z = %d\n", x, y, z ) ;
    return 0 ;
}
```

Output:

x = 10 y = 10 z = 0

```
(f) #include <stdio.h>
int main( )
{
    int i = 65 ;
    char j = 'A' ;
    if ( i == j )
        printf ( "C is WOW\n" ) ;
    else
        printf( "C is a headache\n" ) ;
    return 0 ;
}
```

Output:

C is WOW

[B] Point out the errors, if any, in the following programs:

```
(a) #include <stdio.h>
int main( )
{
    float a = 12.25, b = 12.52 ;
    if ( a = b )
        printf ( "a and b are equal\n" ) ;
    return 0 ;
}
```

No Error. 12.52 would get assigned to **a**, condition would be evaluated to true and **printf()** would get executed.

(b)

```
#include <stdio.h>
int main( )
{
    int j = 10, k = 12 ;
    if ( k >= j )
    {
        {
            k = j ;
            j = k ;
        }
    }
    return 0 ;
}
```

No Error. Any number of pairs of braces can be used.

(c)

```
#include <stdio.h>
int main( )
{
    if ( 'X' < 'x' )
        printf ( "ascii value of X is smaller than that of x\n" );
}
```

No Error. ASCII values of x and X are being compared.

(d)

```
#include <stdio.h>
int main( )
{
    int x = 10 ;
    if ( x >= 2 ) then
        printf ( "%d\n", x );
    return 0 ;
}
```

Error. 'then' cannot be used in C.

```
(e) #include <stdio.h>
int main( )
{
    int x = 10, y = 15 ;
    if ( x % 2 = y % 3 )
        printf ( "Carpathians\n" ) ;
    return 0 ;
}
```

Error. For comparison use == and not =.

```
(f) #include <stdio.h>
int main( )
{
    int x = 30, y = 40 ;
    if ( x == y )
        printf ( "x is equal to y\n" ) ;
    elseif ( x > y )
        printf ( "x is greater than y\n" ) ;
    elseif ( x < y )
        printf ( "x is less than y\n" ) ;
    return 0 ;
}
```

Error. *elseif* is not a keyword in C.

```
(g) #include <stdio.h>
int main( )
{
    int a, b ;
    scanf ( "%d %d", a, b ) ;
    if ( a > b ) ;
        printf ( "This is a game\n" ) ;
    else
        printf ( "You have to play it\n" ) ;
    return 0 ;
}
```

Ampersand (&) should be used before variables in **scanf()**.

[C] Attempt the following:

- (a) If cost price and selling price of an item is input through the keyboard, write a program to determine whether the seller has made profit or incurred loss. Also determine how much profit he made or loss he incurred.

Program:

```
/* Calculate profit or loss */
#include <stdio.h>

int main( )
{
    float cp, sp, p, l ;

    printf ( "\nEnter cost price and selling price: " ) ;
    scanf ( "%f %f", &cp, &sp ) ;

    p = sp - cp ; /* Profit = Selling Price - Cost Price */
    l = cp - sp ; /* Loss = Cost Price - Selling Price */

    if ( p > 0 )
        printf ( "The seller has made a profit of Rs.%f\n", p ) ;

    if ( l > 0 )
        printf ( "The seller is in loss by Rs.%f\n", l ) ;

    if ( p == 0 )
        printf ( "There is no loss, no profit\n" ) ;

    return 0 ;
}
```

- (b) Any integer is input through the keyboard. Write a program to find out whether it is an odd number or even number.

Program:

```
/* Check whether a number is even or odd */
#include <stdio.h>

int main( )
{
    int n ;

    printf ( "\nEnter any number" );
    scanf ( "%d", &n );

    if ( n % 2 == 0 ) /* remainder after division by 2 */
        printf ( "\nThe number is even\n" );
    else
        printf ( "\nThe number is odd\n" );

    return 0 ;
}
```

- (c) Any year is input through the keyboard. Write a program to determine whether the year is a leap year or not. (Hint: Use the % (modulus) operator)

Program:

```
/* Check whether the year is leap or not */
/* Year is Leap if it is a century year and is divisible by 400 */
/* Year is Leap if it is a non-century year and is divisible by 4 */
#include <stdio.h>

int main( )
{
    int yr ;

    printf ( "\nEnter a year:" );
    scanf ( "%d", &yr );
```



```
    if ( yr % 100 == 0 )
    {
        if ( yr % 400 == 0 )
            printf ( "Leap year\n" );
        else
            printf ( "Not a Leap year\n" );
    }
    else
    {
        if ( yr % 4 == 0 )
            printf ( "Leap year\n" );
        else
            printf ( "Not a leap year\n" );
    }
    return 0 ;
}
```

- (d) According to the Gregorian calendar, it was Monday on the date 01/01/01. If any year is input through the keyboard write a program to find out what is the day on 1st January of this year.

Program:

```
/* Calculate the day on 1st January of any year */
#include <stdio.h>

int main( )
{
    int leapdays, firstday, yr ;
    long int normaldays, totaldays ;

    printf ( "Enter year:" );
    scanf ( "%d", &yr );
    normaldays = ( yr - 1 ) * 365L ;
```

```
leapdays = ( yr - 1 ) / 4 - ( yr - 1 ) / 100 + ( yr - 1 ) / 400 ;
totaldays = normaldays + leapdays ;
firstday = totaldays % 7 ;

if ( firstday == 0 )
    printf ( "Monday\n" ) ;

if ( firstday == 1 )
    printf ( "Tuesday\n" ) ;

if ( firstday == 2 )
    printf ( "Wednesday\n" ) ;

if ( firstday == 3 )
    printf ( "Thursday\n" ) ;

if ( firstday == 4 )
    printf ( "Friday\n" ) ;

if ( firstday == 5 )
    printf ( "Saturday\n" ) ;

if ( firstday == 6 )
    printf ( "Sunday\n" ) ;

return 0 ;
}
```

- (e) A five-digit number is entered through the keyboard. Write a program to obtain the reversed number and to determine whether the original and reversed numbers are equal or not.

Program:

```
/* Check whether a number and its reversed number are equal */
# include <stdio.h>

int main( )
```

```
{
    int n, a, b, num ;
    long int revnum = 0 ;

    printf ( "\nEnter a five digit number (less than or equal to 32767): " ) ;
    scanf ( "%d", &n ) ;

    num = n ;
    a = n % 10 ; /* last digit */
    n = n / 10 ; /* remaining digits */
    revnum = revnum + a * 10000L;

    a = n % 10 ; /* 4 th digit */
    n = n / 10 ; /* remaining digits */
    revnum = revnum + a * 1000;

    a = n % 10 ; /* 3 rd digit */
    n = n / 10 ; /* remaining digits */
    revnum = revnum + a * 100;

    a = n % 10 ; /* 2 nd digit */
    n = n / 10 ; /* remaining digits */
    revnum = revnum + a * 10 ;

    a = n % 10 ; /* 1 st digit */
    revnum = revnum + a ;

    if ( revnum == num )
        printf ( "Given number & its reversed number are equal\n" ) ;
    else
        printf ( "Given number & its reversed number are not equal\n" ) ;

    return 0 ;
}
```

- (f) If the ages of Ram, Shyam and Ajay are input through the keyboard, write a program to determine the youngest of the three.

Program:

```
/* Find the youngest amongst three friends */
#include <stdio.h>

int main( )
{
    int r, s, a, young ;

    printf ( "\nEnter age of Ram, Shyam and Ajay: " );
    scanf ( "%d %d %d", &r, &s, &a );

    if ( r < s )
    {
        if ( r < a )
            young = r ;
        else
            young = a ;
    }
    else
    {
        if ( s < a )
            young = s ;
        else
            young = a ;
    }

    printf ( "The youngest of Ram(%d), Shyam(%d) and Ajay(%d) is
            %d\n", r, s, a, young ) ;

    return 0 ;
}
```

- (g) Write a program to check whether a triangle is valid or not, when the three angles of the triangle are entered through the keyboard. A triangle is valid if the sum of all the three angles is equal to 180 degrees.

Program:

```
/* Check whether a triangle is valid or not */
#include <stdio.h>

int main( )
{
    float angle1, angle2, angle3 ;

    printf ( "\nEnter three angles of the triangle: " ) ;
    scanf ( "%f %f %f", &angle1, &angle2, &angle3 ) ;

    if ( ( angle1 + angle2 + angle3 ) == 180 )
        printf ( "The triangle is a valid triangle\n" ) ;
    else
        printf ( "The triangle is an invalid triangle\n" ) ;

    return 0 ;
}
```

- (h) Find the absolute value of a number entered through the keyboard.

Program:

```
/* To find absolute value of number entered through keyboard*/
#include <stdio.h>

int main( )
{
    int no ;
```

```
printf ( "\nEnter any number: " );
scanf ( "%d", &no );
if ( no < 0 )
    no = no * -1 ;
printf ( "The absolute value of given number is %d\n", no );

return 0 ;
}
```

- (i) Given the length and breadth of a rectangle, write a program to find whether the area of the rectangle is greater than its perimeter. For example, the area of the rectangle with length = 5 and breadth = 4 is greater than its perimeter.

Program:

```
/* Find whether area of rectangle is greater than its perimeter */
#include <stdio.h>

int main( )
{
    int l, b, area, peri ;

    printf ( "\nEnter length and breadth of the rectangle: " );
    scanf ( "%d %d", &l, &b );

    area = l * b ;
    peri = 2 * ( l + b ) ;

    if ( area > peri )
        printf ( "area is greater than perimeter\n" );
    else
        printf ( "area is lesser than perimeter\n" );

    return 0 ;
}
```

- (j) Given three points (**x1, y1**), (**x2, y2**) and (**x3, y3**), write a program to check if all the three points fall on one straight line.

Program:

```
/* Check whether three points are co-linear */
# include <stdio.h>
# include <math.h>

int main( )
{
    int x1, y1, x2, y2, x3, y3 ;
    int s1, s2, s3 ;

    printf ( "\nEnter the values of x1 and y1 coordinates of first point: " ) ;
    scanf ( "%d%d", &x1, &y1 ) ;
    printf ( "\nEnter the values of x2 and y2 coordinates of first point: " ) ;
    scanf ( "%d%d", &x2, &y2 ) ;
    printf ( "\nEnter the values of x3 and y3 coordinates of first point: " ) ;
    scanf ( "%d%d", &x3, &y3 ) ;

    /* Calculate Slope of line between each pair of points */
    s1 = abs ( x2- x1 ) / abs ( y2 - y1 ) ;
    s2 = abs ( x3 - x1 ) / abs ( y3 - y1 ) ;
    s3 = abs ( x3 - x2 ) / abs ( y3 - y2 ) ;

    if ( ( s1 == s2 ) && ( s1 == s3 ) )
        printf ( "Points are Co-linear\n" ) ;
    else
        printf ( "Points are NOT Co-linear\n" ) ;

    return 0 ;
}
```

- (k) Given the coordinates (**x, y**) of center of a circle and its radius, write a program that will determine whether a point

lies inside the circle, on the circle or outside the circle. (Hint: Use **sqrt()** and **pow()** functions)

Program:

```
/* Determine position of point with respect to a circle */
/* The center of the circle has been assumed to be at (0, 0) */
#include <stdio.h>

int main( )
{
    int x, y, r ;
    int dis, d ;

    printf ( "\nEnter radius of circle and coordinates of point ( x, y ): " ) ;
    scanf ( "%d %d %d", &r, &x, &y ) ;

    dis = x * x + y * y ; /* or use pow( ) function*/
    d = r * r ;

    if ( dis == d )
        printf ( "Point is on the circle\n" ) ;
    else
    {
        if ( dis > d )
            printf ( "Point is outside the circle\n" ) ;
        else
            printf ( "Point is inside the circle\n" ) ;
    }

    return 0 ;
}
```

- (l) Given a point (**x**, **y**), write a program to find out if it lies on the x-axis, y-axis or on the origin.

Program:


```
/* Determine position of a point with respect to X and Y axes */
#include <stdio.h>

int main( )
{
    int x, y ;

    printf ( "\nEnter the x and y coordinates of a point: " ) ;
    scanf ( "%d%d", &x, &y ) ;

    if ( x == 0 && y == 0 )
        printf ( "Point lies on origin\n" ) ;
    else
        if ( x == 0 && y != 0 )
            printf ( "Point lies on Y axis\n" ) ;
        else
            if ( x != 0 && y == 0 )
                printf ( "Point lies on X axis\n" ) ;
            else
                printf ( "Point neither lies on any axis, nor origin\n" ) ;

    return 0 ;
}
```

CHAPTER FOUR

More Complex Decision Making

[A] If $a = 10$, $b = 12$, $c = 0$, find the values of the expressions in the following table:

Expression	Value
$a \neq 6 \ \&\& \ b > 5$	1
$a == 9 \ \ b < 3$	0
$! (a < 10)$	1
$! (a > 5 \ \&\& \ c)$	1
$5 \ \&\& \ c \neq 8 \ \ !c$	1

[B] What will be the output of the following programs:

(a)

```
#include <stdio.h>
int main( )
{
    int i = 4, z = 12 ;
    if ( i = 5 || z > 50 )
        printf ( "Dean of students affairs\n" ) ;
```

```
        else
            printf ( "Dosa\n" );
        return 0 ;
    }
```

Output:

Dean of students affairs

```
(b) # include <stdio.h>
int main( )
{
    int i = 4, j = -1, k = 0, w, x, y, z ;
    w = i || j || k ;
    x = i && j && k ;
    y = i || j && k ;
    z = i && j || k ;
    printf ( "w = %d x = %d y = %d z = %d\n", w, x, y, z ) ;
    return 0 ;
}
```

Output:

w = 1 x = 0 y = 1 z = 1

```
(c) # include <stdio.h>
int main( )
{
    int x = 20, y = 40, z = 45 ;
    if ( x > y && x > z )
        printf ( "biggest = %d\n", x ) ;
    else if ( y > x && y > z )
        printf ( "biggest = %d\n", y ) ;
    else if ( z > x && z > y )
        printf ( "biggest = %d\n", z ) ;
    return 0 ;
}
```

Output:

biggest = 45

```
(d) #include <stdio.h>
int main( )
{
    int i = -1, j = 1, k, l;
    k = !i && j;
    l = !i || j;
    printf ( "%d %d\n", i, j );
    return 0;
}
```

Output:

-1 1

```
(e) #include <stdio.h>
int main( )
{
    int i = -4, j, num;
    j = ( num < 0 ? 0 : num * num );
    printf ( "%d\n", j );
    return 0;
}
```

Output:

Unpredictable. **num** not initialised

```
(f) #include <stdio.h>
int main( )
{
    int k, num = 30;
    k = ( num > 5 ? ( num <= 10 ? 100 : 200 ) : 500 );
    printf ( "%d\n", num );
    return 0;
}
```

Output:

30

[C] Point out the errors, if any, in the following programs:

(a)

```
#include <stdio.h>
int main( )
{
    int code, flag ;
    if ( code == 1 & flag == 0 )
        printf ( "The eagle has landed\n" ) ;
    return 0 ;
}
```

Error. To combine two conditions use `&&` and not `&`.

(b)

```
#include <stdio.h>
int main( )
{
    char spy = 'a', password = 'z' ;
    if ( spy == 'a' or password == 'z' )
        printf ( "All the birds are safe in the nest\n" ) ;
    return 0 ;
}
```

Error. 'or' cannot be used to combine conditions . Use `||`.

(c)

```
#include <stdio.h>
int main( )
{
    int i = 10, j = 20 ;
    if ( i = 5 ) && if ( j = 10 )
        printf ( "Have a nice day\n" ) ;
    return 0 ;
}
```

Error. Condition should be *if (i == 5 && j == 10)*.

(d)

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

```
int main( )
{
    int x = 10, y = 20 ;
    if ( x >= 2 and y <= 50 ) ;
        printf ( "%d\n", x ) ;
    return 0 ;
}
```

Error. Replace and with && to combine the conditions.

```
(e) # include <stdio.h>
int main( )
{
    int x = 2 ;
    if ( x == 2 && x != 0 ) ;
        printf ( "Hello\n" ) ;
    else
        printf ( "Bye\n" ) ;
    return 0 ;
}
```

Error. The **if** statement should not be terminated by a semicolon.

```
(f) # include <stdio.h>
int main( )
{
    int i = 10, j = 10 ;
    if ( i && j == 10 )
        printf ( "Have a nice day\n" ) ;
    return 0 ;
}
```

No error.

```
(g) # include <stdio.h>
int main( )
{
```

```

    int j = 65 ;
    printf ( "j >= 65 ? %d : %c\n", j ) ;
    return 0 ;
}

```

No Error.

```

(h) #include <stdio.h>
int main( )
{
    int i = 10, j ;
    i >= 5 ? j = 10 : j = 15 ;
    printf ( "%d %d\n", i, j ) ;
    return 0 ;
}

```

Error. LValue required. Parenthesize $j = 10$ and $j = 15$ to eliminate the error.

```

(i) #include <stdio.h>
int main( )
{
    int a = 5, b = 6 ;
    ( a == b ? printf ( "%d\n", a ) ) ;
    return 0 ;
}

```

Error. The $?$ operator must have a matching $:$ operator.

```

(j) #include <stdio.h>
int main( )
{
    int n = 9 ;
    ( n == 9 ? printf ( "Correct\n" ) ; : printf ( "Wrong\n" ) ; ) ;
    return 0 ;
}

```

Error. Remove the $;$ after each **printf**().

[D] Attempt the following:

- (a) Any year is entered through the keyboard, write a program to determine whether the year is leap or not. Use the logical operators **&&** and **||**.

Program:

```
/* Determine whether a year is leap or not */
#include <stdio.h>

int main( )
{
    int year ;

    printf ( "\nEnter year: " );
    scanf ( "%d", &year );

    if ( year % 400 == 0 || year % 100 != 0 && year % 4 == 0 )
        printf ( "Leap year\n" );
    else
        printf ( "Not a leap year\n" );

    return 0 ;
}
```

- (b) Any character is entered through the keyboard, write a program to determine whether the character entered is a capital letter, a small case letter, a digit or a special symbol.

The following table shows the range of ASCII values for various characters.

Characters	ASCII Values
A – Z	65 – 90
a – z	97 – 122
0 – 9	48 – 57
special symbols	0 - 47, 58 - 64, 91 - 96, 123 - 127

Program:

```
/* Check type of character entered from the keyboard */

#include <stdio.h>
int main( )
{
    char ch ;

    printf ( "\nEnter a character from the keyboard: " );
    scanf ( "%c", &ch );

    if ( ch >= 65 && ch <= 90 )
        printf ( "The character is an uppercase letter\n" );

    if ( ch >= 97 && ch <= 122 )
        printf ( "The character is a lowercase letter\n" );

    if ( ch >= 48 && ch <= 57 )
        printf ( "The character is a digit\n" );

    if ( ( ch >= 0 && ch < 48 ) || ( ch > 57 && ch < 65 )
        || ( ch > 90 && ch < 97 ) || ch > 122 )
        printf ( "The character is a special symbol\n" );

    return 0 ;
}
```

}

- (c) A certain grade of steel is graded according to the following conditions:

- (i) Hardness must be greater than 50
- (ii) Carbon content must be less than 0.7
- (iii) Tensile strength must be greater than 5600

The grades are as follows:

Grade is 10 if all three conditions are met
Grade is 9 if conditions (i) and (ii) are met
Grade is 8 if conditions (ii) and (iii) are met
Grade is 7 if conditions (i) and (iii) are met
Grade is 6 if only one condition is met
Grade is 5 if none of the conditions are met

Write a program, which will require the user to give values of hardness, carbon content and tensile strength of the steel under consideration and output the grade of the steel.

Program:

```
/* Check the grade of steel */
# include <stdio.h>

int main( )
{
    float hard, carbon, tensile ;

    printf ( "\nEnter Hardness of steel: " ) ;
    scanf ( "%f", &hard ) ;

    printf ( "\nEnter Carbon content: " ) ;
    scanf ( "%f", &carbon ) ;

    printf ( "\nEnter Tensile strength:" ) ;
    scanf ( "%f", &tensile ) ;
```

```
if ( hard > 50 && carbon < 0.7 && tensile > 5600 )
{
    printf ( "Grade 10\n" );
    exit ( 0 ); /* Terminates the execution */
}

if ( hard > 50 && carbon < 0.7 && tensile <= 5600 )
{
    printf ( "Grade 9\n" );
    exit ( 0 );
}

if ( hard <= 50 && carbon < 0.7 && tensile > 5600 )
{
    printf ( "Grade 8\n" );
    exit ( 0 );
}

if ( hard > 50 && carbon >= 0.7 && tensile > 5600 )
{
    printf ( "Grade 7\n" );
    exit ( 0 );
}

if ( hard > 50 || carbon < 0.7 || tensile > 5600 )
{
    printf ( "Grade 6\n" );
    exit ( 0 );
}

printf ( "Grade 5\n" );

return 0 ;
}
```

- (d) If the three sides of a triangle are entered through the keyboard, write a program to check whether the triangle is valid or not. The triangle is valid if the sum of two sides is greater than the largest of the three sides.

Program:

```
/* Check whether a triangle is valid or not */
#include <stdio.h>

int main( )
{
    int side1, side2, side3, largeside, sum ;

    printf ( "\nEnter three sides of the triangle: " ) ;
    scanf ( "%d %d %d", &side1, &side2, &side3 ) ;

    if ( side1 > side2 )
    {
        if ( side1 > side3 )
        {
            sum = side2 + side3 ;
            largeside = side1 ;
        }
        else
        {
            sum = side1 + side2 ;
            largeside = side3 ;
        }
    }
    else
    {
        if ( side2 > side3 )
        {
            sum = side1 + side3 ;
            largeside = side2 ;
        }
        else
```

```
        {
            sum = side1 + side2 ;
            largeside = side3 ;
        }
    }

    if ( sum > largeside )
        printf ( "The triangle is a valid triangle\n" ) ;
    else
        printf ( "The triangle is an invalid triangle\n" ) ;

    return 0 ;
}
```

- (e) If the three sides of a triangle are entered through the keyboard, write a program to check whether the triangle is isosceles, equilateral, scalene or right-angled triangle.

Program:

```
/* Determine the type of triangle */
# include <stdio.h>

int main( )
{
    int s1, s2, s3, a, b, c ;

    printf ( "\nEnter three sides of a triangle: " ) ;
    scanf ( "%d %d %d", &s1, &s2, &s3 ) ;

    if ( s1 != s2 && s2 != s3 && s3 != s1 )
        printf ( "Scalene triangle\n" ) ;

    if ( ( s1 == s2 ) && ( s2 != s3 ) )
        printf ( "Isosceles triangle\n" ) ;

    if ( ( s2 == s3 ) && ( s3 != s1 ) )
        printf ( "Isosceles triangle\n" ) ;
}
```

```

if ( ( s1 == s3 ) && ( s3 != s2 ) )
    printf ( "Isosceles triangle\n" );

if ( s1 == s2 && s2 == s3 )
    printf ( "Equilateral triangle\n" );

a = ( s1 * s1 ) == ( s2 * s2 ) + ( s3 * s3 );
b = ( s2 * s2 ) == ( s1 * s1 ) + ( s3 * s3 );
c = ( s3 * s3 ) == ( s1 * s1 ) + ( s2 * s2 );

if ( a || b || c )
    printf ( "Right-angled triangle\n" );

return 0 ;
}

```

- (f) In boxing the weight class of a boxer is decided as per the following table. Write a program that receives weight as input and prints out the boxer's weight class.

Boxer Class	Weight in Pounds
Flyweight	< 115
Bantamweight	115 - 121
Featherweight	122 - 153
Middleweight	154 – 189
Heavyweight	>= 190

Program:

```

/* Decide Boxer class based on his weight */
#include <stdio.h>

```

```
int main( )
{
    int wt ;

    printf ( "Enter weight in pounds: " ) ;
    scanf ( "%d", &wt ) ;

    if ( wt < 115 )
        printf ( "Flyweight category\n" ) ;

    if ( wt >= 115 && wt <= 121 )
        printf ( "Bantamweight category\n" ) ;

    if ( wt >= 122 && wt <= 153 )
        printf ( "Featherweight category\n" ) ;

    if ( wt >= 154 && wt <= 189 )
        printf ( "Middleweight category\n" ) ;

    if ( wt >= 190 )
        printf ( "Heavyweight category\n" ) ;

    return 0 ;
}
```

- (g) In digital world colors are specified in Red-Green-Blue (RGB) format, with values of R, G, B varying on an integer scale from 0 to 255. In print publishing the colors are mentioned in Cyan-Magenta-Yellow-Black (CMYK) format, with values of C, M, Y, and K varying on a real scale from 0.0 to 1.0. Write a program that converts RGB color to CMYK color as per the following formulae:

$$White = \text{Max}(Red / 255, Green / 255, Blue / 255)$$

$$Cyan = \left(\frac{White - Red / 255}{White} \right)$$

$$\text{Magenta} = \left(\frac{\text{White} - \text{Green} / 255}{\text{White}} \right)$$

$$\text{Yellow} = \left(\frac{\text{White} - \text{Blue} / 255}{\text{White}} \right)$$

$$\text{Black} = 1 - \text{White}$$

Note that if the RGB values are all 0, then the CMY values are all 0 and the K value is 1.

Program:

```
/* Color conversion from RGB to CMYK format */
#include <stdio.h>

int main( )
{
    float red, green, blue ;
    float white, cyan, magenta, yellow, black ;
    float max ;

    printf ( "\nEnter Red, Green, Blue values (0 to 255): " ) ;
    scanf ( "%f %f %f", &red, &green, &blue ) ;

    if ( red == 0 && green == 0 && blue == 0 )
    {
        cyan = magenta = yellow = 0 ;
        black = 1 ;
    }
    else
    {
        red = red / 255 ;
        green = green / 255 ;
        blue = blue / 255 ;
```



```
    max = red ;
    if ( green > max )
        max = green ;
    if ( blue > max )
        max = blue ;

    white = max ;
    cyan = ( white - red ) / white ;
    magenta = ( white - green ) / white ;
    yellow = ( white - blue ) / white ;
    black = 1 - white ;
}

printf ( "CMYK = %f %f %f %f\n", cyan, magenta, yellow, black ) ;

return 0 ;
}
```

- (h) Write a program that receives month and date of birth as input and prints the corresponding Zodiac sign based on the following table:

Zodiac Sign	From - To
Capricorn	December 22 - January 19
Aquarius	January 20 - February 17
Pisces	February 18 - March 19
Aries	March 20 - April 19
Taurus	April 20 - May 20
Gemini	May 21 - June 20
Cancer	June 21 - July 22
Leo	July 23 - August 22
Virgo	August 23 - September 22
Libra	September 23 - October 22
Scorpio	October 23 - November 21
Sagittarius	November 22 - December 21

Program:

```
/* Decide Zodiac sign based on date and month of birth */
#include <stdio.h>

int main( )
{
    int d, m ;

    printf ( "Enter day and month of birth: " ) ;
    scanf ( "%d %d", &d, &m ) ;

    if ( d >= 22 && m == 12 || d <= 19 && m == 1 )
        printf ( "Capricorn\n" ) ;

    if ( d >= 20 && m == 1 || d <= 17 && m == 2 )
        printf ( "Aquarius\n" ) ;

    if ( d >= 18 && m == 2 || d <= 19 && m == 3 )
```

```
    printf ( "Pisces\n" ) ;

    if ( d >= 20 && m == 3 || d <= 19 && m == 4 )
        printf ( "Aries\n" ) ;

    if ( d >= 20 && m == 4 || d <= 20 && m == 5 )
        printf ( "Taurus\n" ) ;

    if ( d >= 21 && m == 5 || d <= 20 && m == 6 )
        printf ( "Gemini\n" ) ;

    if ( d >= 21 && m == 6 || d <= 22 && m == 7 )
        printf ( "Cancer\n" ) ;

    if ( d >= 23 && m == 7 || d <= 22 && m == 8 )
        printf ( "Leo\n" ) ;

    if ( d >= 23 && m == 8 || d <= 22 && m == 9 )
        printf ( "Virgo\n" ) ;

    if ( d >= 23 && m == 9 || d <= 22 && m == 10 )
        printf ( "Libra\n" ) ;

    if ( d >= 23 && m == 10 || d <= 21 && m == 11 )
        printf ( "Scorpio\n" ) ;

    if ( d >= 22 && m == 11 || d <= 21 && m == 12 )
        printf ( "Sagittarius\n" ) ;

    return 0 ;
}
```

- (i) The Body Mass Index (BMI) is defined as ratio of the weight of a person (in kilograms) to the square of the height (in meters). Write a program that receives weight and height, calculates the BMI, and reports the BMI category as per the following table:

BMI Category	BMI
Starvation	< 15
Anorexic	15.1 to 17.5
Underweight	17.6 to 18.5
Ideal	18.6 to 24.9
Overweight	25 to 25.9
Obese	30 to 30.9
Morbidly Obese	>= 40

Program:

```
/* Determine BMI category */
# include <stdio.h>
# include <math.h>

int main( )
{
    float wt, ht, bmi ;

    printf ( "Enter weight in kg and height in meters: " ) ;
    scanf ( "%f %f", &wt, &ht ) ;
    bmi = wt / ( ht * ht ) ;
    printf ( "Body Mass Index = %f\n", bmi ) ;

    if ( bmi < 15 )
        printf ( "BMI Category: Starvation\n" ) ;
    else if ( bmi < 17.5 )
        printf ( "BMI Category: Anorexic\n" ) ;
    else if ( bmi < 18.5 )
        printf ( "BMI Category: Underweight\n" ) ;
    else if ( bmi < 25 )
        printf ( "BMI Category: Ideal\n" ) ;
    else if ( bmi < 30 )
```

```
        printf ( "BMI Category: Overweight\n" );  
    else if ( bmi < 40 )  
        printf ( "BMI Category: Obese\n" );  
    else  
        printf ( "BMI Category: Morbidly Obese\n" );  
  
    return 0 ;  
}
```

[E] Attempt the following:

(a) Using conditional operators determine:

- (1) Whether the character entered through the keyboard is a lower case alphabet or not.

Program:

```
/* Determine character case using conditional operators */  
#include <stdio.h>  
  
int main( )  
{  
    char ch ;  
  
    printf ( "Enter character" );  
    scanf ( "%c", &ch );  
    ch >= 97 && ch <= 122 ? printf ( "Character entered is lower  
        case\n" ) : printf ( "Character entered is not lower case\n" );  
  
    return 0 ;  
}
```

- (2) Whether a character entered through the keyboard is a special symbol or not.

Program:

```
/* Determine whether a character is a special symbol */
```

```
#include <stdio.h>

int main( )
{
    char ch ;

    printf ( "Enter character: " ) ;
    scanf ( "%c", &ch ) ;
    ( ( ch >= 0 && ch <= 47 ) || ( ch >= 58 && ch <= 64 ) ||
      ( ch >= 91 && ch <= 96 ) || ( ch >= 123 ) ) ?
        printf ( "Character entered is a special symbol\n" ) :
        printf ( "Character entered is not a special symbol\n" ) ;

    return 0 ;
}
```

- (b) Write a program using conditional operators to determine whether a year entered through the keyboard is a leap year or not.

Program:

```
/* Determine whether a year is leap or not using conditional operators */
#include <stdio.h>

int main( )
{
    int year ;

    printf ( "Enter Year: " ) ;
    scanf ( "%d", &year ) ;
    year % 100 == 0 ? ( year % 400 == 0 ? printf ( " Leap Year\n" )
    : printf ( "Not a Leap Year\n" ) ) : ( year % 4 == 0 ?
    printf ( "Leap Year\n" ) : printf ( "Not A Leap Year\n" ) ) ;

    return 0 ;
}
```

- (c) Write a program to find the greatest of three numbers entered through the keyboard. Use conditional operators.

Program:

```
/* Determine greatest of 3 numbers using conditional operators */
# include <stdio.h>

int main( )
{
    int n1, n2, n3, great ;

    printf ( "\nEnter three numbers: " );
    scanf ( "%d %d %d", &n1, &n2, &n3 );

    great = n1 > n2 ? ( n1 > n3 ? n1 : n3 ) : ( n2 > n3 ? n2 : n3 );

    printf ( "Greatest number is: %d", great );

    return 0 ;
}
```

- (d) Write a program to receive value of an angle in degrees and check whether sum of squares of sine and cosine of this angle is equal to 1.

Program:

```
/* Determine whether sum of squares of sine and cosine of an angle is
   equal to 1 */
# include <stdio.h>

int main( )
{
    int n1, n2, n3, great ;

    printf ( "\nEnter angle in degrees: " );
```

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

angle = angle * 3.14 / 180 ;
sum = pow ( sin ( angle ), 2 ) + pow ( cos ( angle ), 2 ) ;

if ( sum == 1 )
    printf ( " sum of squares of sine and cosine is equal to 1" ) ;
else
    printf ( " sum of squares of sine and cosine is not equal to 1" ) ;

return 0 ;
}
```

(e) Rewrite the following programs using conditional operators.

```
# include <stdio.h>
int main( )
{
    float sal ;
    printf ( "Enter the salary" ) ;
    scanf ( "%f", &sal ) ;
    if ( sal >= 25000 && sal <= 40000 )
        printf ( "Manager\n" ) ;
    else
        if ( sal >= 15000 && sal < 25000 )
            printf ( "Accountant\n" ) ;
        else
            printf ( "Clerk\n" ) ;
    return 0 ;
}
```

Program:

```
# include <stdio.h>
int main( )
{
    float sal ;
    printf ( "Enter the salary" ) ;
```



```
scanf ( "%f", &sal );  
( sal >= 25000 && sal <= 40000 ? printf ( "Manager\n" ) :  
  ( sal >= 15000 && sal < 25000 ? printf ( "Accountant\n" ) :  
    printf ( "Clerk\n" ) ) );  
return 0 ;  
}
```

CHAPTER

FIVE

Loop Control Instruction

[A] What will be the output of the following programs:

(a)

```
#include <stdio.h>
int main( )
{
    int i = 1 ;
    while ( i <= 10 ) ;
    {
        printf ( "%d\n", i ) ;
        i++ ;
    }
    return 0 ;
}
```

Output:

No Output Indefinite while loop because of a ‘;’ at the end of while

(b)

```
#include <stdio.h>
int main( )
{
    int x = 4, y, z ;
```

```
    y = --x ;
    z = x-- ;
    printf ( "%d %d %d\n", x, y, z ) ;
    return 0 ;
}
```

Output:

2 3 3

```
(c) # include <stdio.h>
int main( )
{
    int x = 4, y = 3, z ;
    z = x-- - y ;
    printf ( "%d %d %d\n", x, y, z ) ;
    return 0 ;
}
```

Output:

3 3 1

```
(d) # include <stdio.h>
int main( )
{
    while ( 'a' < 'b' )
        printf ( " malayalam is a palindrome\n" ) ;
    return 0 ;
}
```

Output:

‘malayalam is a palindrome’ will be printed indefinitely

```
(e) # include <stdio.h>
int main( )
{
    int i ;
    while ( i = 10 )
```

```
    {  
        printf ( "%d\n", i );  
        i = i + 1 ;  
    }  
    return 0 ;  
}
```

Output:

10 will be printed indefinitely.

```
(f) #include <stdio.h>  
int main( )  
{  
    float x = 1.1 ;  
    while ( x == 1.1 )  
    {  
        printf ( "%f\n", x ) ;  
        x = x - 0.1 ;  
    }  
    return 0 ;  
}
```

Output:

No output. Since a **float** variable is compared with **double** constant, condition will not satisfy.

[B] Attempt the following:

- (a) Write a program to calculate overtime pay of 10 employees. Overtime is paid at the rate of Rs. 12.00 per hour for every hour worked above 40 hours. Assume that employees do not work for fractional part of an hour.

Program:

```
/* Determine overtime pay of 10 employees.*/  
#include <stdio.h>
```

```
int main( )
{
    float otpay ;
    int hour, i = 1 ;

    while ( i <= 10 ) /* Loop for 10 employees */
    {
        printf ( "\nEnter no. of hours worked: " ) ;
        scanf ( "%d", &hour ) ;

        if ( hour >= 40 )
        {
            otpay = ( hour - 40 ) * 12 ;
            printf ( "No of hours worked = %d \n
                    Overtime pay = Rs. %f\n", hour, otpay ) ;
        }
        else
        {
            otpay = 0 ;
            printf ( "No of hours worked (%d) is less than
                    40 Hrs.\nHence no overtime pay\n", hour ) ;
        }
        i++ ;
    }

    return 0 ;
}
```

- (b) Write a program to find the factorial value of any number entered through the keyboard.

Program:

```
/* Calculation of factorial of any number */
#include <stdio.h>

int main( )
{
```

```
int num, i = 1 ;
unsigned long int fact = 1 ;

/* factorial of 34 is beyond range of unsigned long int */
printf ( "Enter any number (less than 34): " ) ;
scanf ( "%d", &num ) ;

while ( i <= num )
{
    fact = fact * i ;
    i++ ;
}
printf ( "factorial of %d = %lu\n", num, fact ) ;

return 0 ;
}
```

- (c) Two numbers are entered through the keyboard. Write a program to find the value of one number raised to the power of another.

Program:

```
/* Compute value of one number raised to another */
#include <stdio.h>

int main( )
{
    int x, y, i = 1 ;
    long int power = 1 ;

    printf ( "\nEnter two numbers: " ) ;
    scanf ( "%d %d", &x, &y ) ;

    while ( i <= y )
    {
        power = power * x ;
        i++ ;
    }
}
```

```
    }  
    printf ( "%d to the power %d is %ld\n", x, y, power ) ;  
  
    return 0 ;  
}
```

- (d) Write a program to print all the ASCII values and their equivalent characters using a **while** loop. The ASCII values vary from 0 to 255.

Program:

```
/* Print ASCII values and their corresponding characters */  
#include <stdio.h>  
  
int main( )  
{  
    int i = 0 ;  
  
    while ( i <= 255 )  
    {  
        printf ( "%d %c\n", i, i ) ;  
        i++ ;  
    }  
  
    return 0 ;  
}
```

- (e) Write a program to print out all Armstrong numbers between 1 and 500. If sum of cubes of each digit of the number is equal to the number itself, then the number is called an Armstrong number. For example, $153 = (1 * 1 * 1) + (5 * 5 * 5) + (3 * 3 * 3)$

Program:

```
/* Generate all Armstrong numbers between 1 & 500 */
```

```
#include <stdio.h>

int main( )
{
    int i = 1, a, b, c ;
    printf ( "Armstrong numbers between 1 & 500 are:\n" ) ;

    while ( i <= 500 )
    {
        a = i % 10 ; /* extract last digit */
        b = i % 100 ;
        b = ( b - a ) / 10 ; /* extract second digit */
        c = i / 100 ; /* extract first digit */

        if ( ( a * a * a ) + ( b * b * b ) + ( c * c * c ) == i )
            printf ( "%d\n", i ) ;

        i++ ;
    }

    return 0 ;
}
```

- (f) Write a program for a matchstick game being played between the computer and a user. Your program should ensure that the computer always wins. Rules for the game are as follows:

- There are 21 matchsticks.
- The computer asks the player to pick 1, 2, 3, or 4 matchsticks.
- After the person picks, the computer does its picking.
- Whoever is forced to pick up the last matchstick loses the game.

Program:

```
/* Match stick game */
#include <stdio.h>
```



```
int main( )
{
    int m = 21, p, c ;

    while ( 1 )
    {
        printf ( "\n\nNo. of matches left = %d\n", m ) ;
        printf ( "Pick up 1, 2, 3 or 4 matches: " ) ;
        scanf ( "%d", &p ) ;

        if ( p > 4 || p < 1 )
            continue ;

        m = m - p ;
        printf ( "No. of matches left = %d\n", m ) ;

        c = 5 - p ;
        printf ( "Out of which computer picked up %d\n", c ) ;

        m = m - c ;
        if ( m == 1 )
        {
            printf ( "Number of matches left %d\n\n", m ) ;
            printf ( "You lost the game !!\n" ) ;
            break ;
        }
    }

    return 0 ;
}
```

- (g) Write a program to enter numbers till the user wants. At the end it should display the count of positive, negative and zeros entered.

Program:

```
/* Count number of positives, negatives and zeros */
#include <stdio.h>

int main( )
{
    int pos, neg, zero, num ;
    char ans = 'y' ;

    pos = neg = zero = 0 ;

    while ( ans == 'y' || ans == 'Y' )
    {
        printf ( "\nEnter a number: " ) ;
        scanf ( "%d", &num ) ;

        if ( num == 0 )
            zero++ ;

        if ( num > 0 )
            pos++ ;

        if ( num < 0 )
            neg++ ;

        fflush ( stdin ) ; // clears standard input stream

        printf ( "\nDo you want to continue? " ) ;
        scanf ( "%c", &ans ) ;
    }

    printf ( "You entered %d positive number(s)\n", pos ) ;
    printf ( "You entered %d negative number(s)\n", neg ) ;
    printf ( "You entered %d zero(s)\n", zero ) ;

    return 0 ;
}
```

- (h) Write a program to receive an integer and find its octal equivalent. Hint: To obtain octal equivalent of an integer, divide it continuously by 8 till dividend doesn't become zero, then write the remainders obtained in reverse direction.

Program:

```
/* Find octal equivalent of a number */
#include <stdio.h>
#include <math.h>

int main( )
{
    int n1, n2, rem, oct, p ;

    printf ( "\nEnter any number: " );
    scanf ( "%d", &n1 );

    n2 = n1 ;
    p = oct = 0 ;

    while ( n1 > 0 )
    {
        rem = n1 % 8 ;
        n1 = n1 / 8 ;
        oct = oct + rem * pow ( 10, p ) ;
        p++ ;
    }

    printf ( "The octal equivalent of %d is %d\n", n2, oct ) ;

    return 0 ;
}
```

- (i) Write a program to find the range of a set of numbers. Range is the difference between the smallest and biggest number in the list.

Program:

```
/* Program to find the range of a set of numbers */
#include <stdio.h>

int main( )
{
    int n, no, flag, small, big, range ;

    flag = 0 ;

    printf ( "\nHow many numbers are there in a set? " ) ;
    scanf ( "%d", &n ) ;

    while ( n > 0 )
    {
        printf ( "\nEnter no: " ) ;
        scanf ( "%d", &no ) ;

        if ( flag == 0 )
        {
            small = big = no ;
            flag = 1 ;
        }
        else
        {
            if ( no > big )
                big = no ;
            if ( no < small )
                small = no ;
        }
        n-- ;
    }

    if ( small < 0 )
        range = small + big ;
    else
        range = big - small ;
}
```

```
    if ( range < 0 )  
        range = range * -1 ;  
  
    printf ( "\nThe range of given set of numbers is %d\n", range ) ;  
  
    return 0 ;  
}
```

CHAPTER SIX

More Complex Repetitions

[A] What will be the output of the following programs:

(a)

```
#include <stdio.h>
int main()
{
    int i = 0 ;
    for ( ; i ; )
        printf ( "Here is some mail for you\n" ) ;
    return 0 ;
}
```

Output:

No Output

(b)

```
#include <stdio.h>
int main()
{
    int i ;
    for ( i = 1 ; i <= 5 ; printf ( "%d\n", i ) ) ;
        i++ ;
    return 0 ;
}
```

Output:

1 will be printed indefinite number of times.

```
(c) #include <stdio.h>
int main( )
{
    int i = 1, j = 1 ;
    for ( ; ; )
    {
        if ( i > 5 )
            break ;
        else
            j += i ;
        printf ( "%d\n", j ) ;
        i += j ;
        return 0 ;
    }
}
```

Output:

2
5

[B] Answer the following:

(a) The three parts of the loop expression in the **for** loop are:

the initialisation expression
the testing expression
the incrementation expression

(b) The **break** statement is used to exit from:

1. an **if** statement
2. a **for** loop
3. a program

4. the **main()** function

Answer:

(2) a **for** loop

(c) A **do-while** loop is useful when we want that the statements within the loop must be executed:

1. Only Once
2. At least once
3. More than once
4. None of the above

Answer:

(2) At least once

(d) In what sequence the initialization, testing and execution of body is done in a **do-while** loop?

1. Initialization, execution of body, testing
2. Execution of body, initialization, testing
3. Initialization, testing, execution of body
4. None of the above

Answer:

(1) Initialization, execution of body, testing

(e) Which of the following is not an infinite loop?

1.

```
int i = 1 ;
while ( 1 )
{
    i++ ;
}
```

2.

```
for ( ; ; ) ;
```

3.

```
int True = 0, false ;
while ( True )
{
    False = 1 ;
}
```

4.

```
int y, x = 0 ;
do
{
    y = x ;
} while ( x == 0 ) ;
```


Answer:

3

- (f) Which keyword is used to take the control to the beginning of the loop?

Answer:

continue

- (g) How many times the **while** loop in the following C code will get executed?

```
#include <stdio.h>
int main( )
{
    int j = 1 ;
    while ( j <= 255 ) ;
    {
        printf ( "%c %d\n", j, j ) ;
        j++;
    }
    return 0 ;
}
```

Answer:

Infinite times, because of ; at the end of **while (j <= 255)**

- (h) Which of the following statements are true for the following program?

```
#include <stdio.h>
int main( )
{
    int x = 10, y = 100 % 90 ;
    for ( i = 1 ; i <= 10 ; i++ ) ;
}
```

```
    if ( x != y ) ;  
        printf ( "x = %d y = %d\n", x, y ) ;  
    return 0 ;  
}
```

- (1) The **printf()** function is called 10 times.
- (2) The program will produce the output x = 10 y = 10.
- (3) The ; after the **if (x != y)** would NOT produce an error.
- (4) The program will not produce any output.
- (5) The **printf()** function is called infinite times.

Answer:

- (2) The program will produce the output x = 10 y = 10.

(i) Which of the following statement is true about a **for** loop used in a C program?

- (1) **for** loop works faster than a **while** loop.
- (2) All things that can be done using a **for** loop can also be done using a **while** loop.
- (3) **for (; ;)** implements an infinite loop.
- (4) **for** loop can be used if we want statements in a loop to get executed at least once.
- (5) **for** loop works faster than a **do-while** loop.

Answer:

- (2), (3), (4).

[C] Attempt the following:

- (a) Write a program to print all prime numbers from 1 to 300.
(Hint: Use nested loops, **break** and **continue**)

Program:

```
/* Generate all prime numbers from 1 to 300 */
```

```
#include <stdio.h>

int main( )
{
    int i, n = 1 ;

    printf ( "\nPrime numbers between 1 & 300 are :\n1\t" );

    while ( n <= 300 ) /* Loop to check numbers upto 300 */
    {
        i = 2 ;
        while ( i < n ) /* Loop starting from 2 to the number */
        {
            if ( n % i == 0 )
                break ; /* takes control out of the inner while as soon
                           as the number is fully divisible */
            else
                i++ ;
        }

        if ( i == n )
            printf ( "%d\t", n ) ;

        n++ ;
    }

    return 0 ;
}
```

- (b) Write a program to fill the entire screen with a smiling face. The smiling face has an ASCII value 1.

Program:

```
/* Fill entire screen with smiling face */
#include <stdio.h>

int main( )
```

```

{
    int r, c ;

    for ( r = 0 ; r <= 24 ; r++ ) /* Fills rows 0 to 24 */
        for ( c = 0 ; c <= 79 ; c++ ) /* Fills columns 0 to 79 */
            printf ( "%c", 1 ) ;

    return 0 ;
}

```

- (c) Write a program to add first seven terms of the following series using **for** loop:

$$\frac{1}{1!} + \frac{2}{2!} + \frac{3}{3!} + \dots$$

Program:

```

/* Sum of first seven terms of a series */
#include <stdio.h>

int main( )
{
    int i = 1, j ;
    float fact, sum = 0.0 ;

    while ( i <= 7 )
    {
        fact = 1.0 ;
        for ( j = 1 ; j <= i ; j++ )
            fact = fact * j ;

        sum = sum + i / fact ;
        i++ ;
    }
    printf ( "Sum of series = %f\n", sum ) ;

    return 0 ;
}

```

```
}
```

- (d) Write a program to generate all combinations of 1, 2 and 3 using **for** loop.

Program:

```
/* Generate all possible combinations of 1 2 3 */
#include <stdio.h>

int main( )
{
    int i = 1, j = 1, k = 1 ;

    for ( i = 1 ; i <= 3 ; i++ ) /* 1st digit */
    {
        for ( j = 1 ; j <= 3 ; j++ ) /* 2nd digit */
        {
            for ( k = 1 ; k <= 3 ; k++ ) /* 3rd digit */
                printf ( "%d%d%d\n" , i , j , k );
        }
    }

    return 0 ;
}
```

- (e) A machine is purchased which will produce earning of Rs. 1000 per year while it lasts. The machine costs Rs. 6000 and will have a salvage value of Rs. 2000 when it is condemned. If 9 percent per annum can be earned on alternate investments, write a program to determine what will be the minimum life of the machine to make it a more attractive investment compared to alternative investment?

Program:

```
/* Determine minimum life of the machine */
```

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

int main( )
{
    int year = 1 ;
    float principal = 6000, salvagevalue = 2000, yearlyprofit = 1000 ;
    float valueoption1, valueoption2, interest ;

    while ( true )
    {
        valueoption1 = salvagevalue + yearlyprofit * year ;
        interest = principal * 0.09f * year ;
        valueoption2 = principal + interest ;
        printf ( "year = %2d value option 1 = %10.2f\n", year, valueoption1, valueoption2 ) ;

        if ( valueoption1 > valueoption2 )
            break ;

        year++ ;
    }

    printf ( "Minimum life of the Machine is %d Years\n", year - 1 ) ;
    return 0 ;
}
```

- (f) Write a program to print the multiplication table of the number entered by the user. The table should get displayed in the following form:

```
29 * 1 = 29
29 * 2 = 58
...
```

Program:

```
/* Generate and print table of a given number */
#include <stdio.h>

int main( )
{
    int i, num ;

    printf ( "\nEnter the number: " );
    scanf ( "%d", &num );

    for ( i = 1 ; i <= 10 ; i++ )
        printf ( "%d * %d = %d\n", num, i, num * i );

    return 0 ;
}
```

- (g) According to a study, the approximate level of intelligence of a person can be calculated using the following formula:

$$i = 2 + (y + 0.5x)$$

Write a program that will produce a table of values of **i**, **y** and **x**, where **y** varies from 1 to 6, and, for each value of **y**, **x** varies from 5.5 to 12.5 in steps of 0.5.

Program:

```
/* Generate and print intelligence table */
#include <stdio.h>

int main( )
{
    int y ;
    float i, x ;

    for ( y = 1 ; y <= 6 ; y++ )
    {
        for ( x = 5.5 ; x <= 12.5 ; x += 0.5 )
```

```

        {
            i = 2 + ( y + 0.5 * x );
            printf ( "y = %d, x = %f i = %f\n", y, x, i );
        }
    }

    return 0 ;
}

```

- (h) When interest compounds **q** times per year at an annual rate of **r** % for **n** years, the principal **p** compounds to an amount **a** as per the following formula

$$a = p (1 + r / q)^{nq}$$

Write a program to read 10 sets of **p**, **r**, **n** & **q** and calculate the corresponding **as**.

Program:

```

/* Compound interest calculation */
# include <stdio.h>
# include <math.h>

int main( )
{
    float q, r, n, p, a ;
    int i ;

    for ( i = 1 ; i < 10 ; i++ )
    {
        printf ( "\nEnter the principal amount:" ) ;
        scanf ( "%f", &p ) ;
        printf ( "\nEnter the rate of interest:" ) ;
        scanf ( "%f", &r ) ;
        printf ( "\nEnter the number of years: " ) ;
        scanf ( "%f", &n ) ;
        printf ( "\nEnter the compounding period: " ) ;

```



```

scanf ( "%f", &q );

a = p + pow ( ( 1 + ( r / q ) ), ( n * q ) );

printf ( "\n\nTotal amount = %f\n", a );
}

return 0 ;
}

```

- (i) The natural logarithm can be approximated by the following series.

$$\frac{x-1}{x} + \frac{1}{2} \left(\frac{x-1}{x} \right)^2 + \frac{1}{2} \left(\frac{x-1}{x} \right)^3 + \frac{1}{2} \left(\frac{x-1}{x} \right)^4 + \dots$$

If **x** is input through the keyboard, write a program to calculate the sum of first seven terms of this series.

Program:

```

/* Compute natural logarithm */
# include <stdio.h>
# include <math.h>

int main( )
{
    int x, i ;
    float result = 0 ;

    printf ( "\nEnter the value of x: " );
    scanf ( "%d", &x );

    for ( i = 1; i <= 7 ; i++ )
    {
        if ( i == 1 )
            result = result + pow ( ( x - 1.0 ) / x, i );
        else

```

```
        result = result + ( 1.0 / 2 ) * pow ( ( x - 1.0 ) / x, i );
    }

    printf ( "\nLog ( %d ) = %f\n", x, result );

    return 0 ;
}
```

- (j) Write a program to generate all Pythagorean Triplets with side length less than or equal to 30.

Program:

```
/* Generate Pythagorean Triplets */
#include <stdio.h>

int main()
{
    int i, j, k ;

    for ( i = 1 ; i <= 30 ; i++ )
    {
        for ( j = 1 ; j <= 30 ; j++ )
        {
            for ( k = 1 ; k <= 30 ; k++ )
            {
                if ( i * i + j * j == k * k )
                    printf ( "%d %d %d\n", i, j, k );
            }
        }
    }

    return 0 ;
}
```

- (k) Population of a town today is 100000. The population has increased steadily at the rate of 10 % per year for last 10

years. Write a program to determine the population at the end of each year in the last decade.

Program:

```
/* Determine population growth over last decade */
#include <stdio.h>
#include <math.h>

int main( )
{
    int pop, n ;
    float p, r ;

    r = 10 ;
    p = 100000 ;

    for ( n = 1 ; n <= 10 ; n++ )
    {
        pop = p / pow ( ( 1 + r / 100 ), n ) ;
        printf ( "Population %d years ago = %d\n", n, pop ) ;
    }

    return 0 ;
}
```

- (1) Ramanujan number is the smallest number that can be expressed as sum of two cubes in two different ways. Write a program to print all such numbers up to a reasonable limit.

Program:

```
/* Generate Ramanujan numbers */
#include <stdio.h>

int main( )
{
```

```

int i, j, k, l ;

for ( i = 1 ; i <= 30 ; i++ )
{
    for ( j = 1 ; j <= 30 ; j++ )
    {
        for ( k = 1 ; k <= 30 ; k++ )
        {
            for ( l = 1 ; l <= 30 ; l++ )
            {
                if ( ( i != j && i != k && i != l ) &&
                    ( j != i && j != k && j != l ) &&
                    ( k != i && k != j && k != l ) &&
                    ( l != i && l != j && l != k ) )
                {
                    if ( i * i * i + j * j * j == k * k * k + l * l * l )
                        printf ( "%d %d %d %d\n", i, j, k, l ) ;
                }
            }
        }
    }
}

return 0 ;
}

```

- (m) Write a program to print 24 hours of day with suitable suffixes like AM, PM, Noon and Midnight.

Program:

```

/* Print hours of the day with suitable suffixes */
#include <stdio.h>

int main()
{
    int hour ;

```

```
for ( hour = 0 ; hour <= 23 ; hour++ )
{
    if ( hour == 0 )
    {
        printf ( "12 Midnight\n" ) ;
        continue ;
    }

    if ( hour < 12 )
        printf ( "%d AM\n", hour ) ;

    if ( hour == 12 )
        printf ( "12 Noon\n" ) ;

    if ( hour > 12 )
        printf ( "%d PM\n", hour % 12 ) ;

}
return 0 ;
}
```

(n) Write a program to produce the following output:

```

          1
        2   3
      4     5     6
    7       8       9      10
```

Program:

```
/* Produce the given pattern */
# include <stdio.h>

int main( )
{
    int i , j, k, l, sp ;
```

```

    sp = 20 ;

    for ( i = 1, k = 1 ; i < 5 ; i++ )
    {
        for ( l = 1 ; l <= sp ; l++ )
            printf ( " " ) ;
        sp -= 2 ;
        for ( j = 1 ; j <= i ; j++ , k++ )
            printf ( " %d ", k ) ;
        printf ( "\n" ) ;
    }

    return 0 ;
}

```

(o) Write a program to produce the following output:

```

A B C D E F G F E D C B A
A B C D E F      F E D C B A
A B C D E          E D C B A
A B C D              D C B A
A B C                  C B A
A B                      B A
A                          A

```

Program:

```

/* Produce the given pattern */
# include <stdio.h>

int main( )
{
    int i = 1, x = 71, blanks = 0, j, val , k ;

    while ( i <= 7 )

```

```
{
    j = 65 ; /* ASCII value of A */
    val = x ;
    while ( j <= val )
    {
        printf ( "%c", j ) ;
        j++ ;
    }
    if ( i == 1 )
        val-- ;

    k = 1 ;

    while ( k <= blanks )
    {
        printf ( " " ) ;
        k++ ;
    }
    blanks = 2 * i - 1 ;

    while ( val >= 65 )
    {
        printf ( "%c", val ) ;
        val-- ;
    }
    printf ( "\n" ) ;
    x-- ;
    i++ ;
}

return 0 ;
}
```

(p) Write a program to produce the following output:

```
      1
    1      1
```

```

        1      2      1
      1      3      3      1
    1      4      6      4      1

```

Program:

```

/* Produce the given pattern */
#include <stdio.h>

int main()
{
    int i, j, k, t, f1, f2, f3, z, sp;
    sp = 20;

    for ( i = 0 ; i <= 4 ; i++ )
    {
        for ( k = 0 ; k < sp - i ; k++ )
            printf ( " " );
        sp -= 2;
        for ( j = 0 ; j <= i ; j++ )
        {
            f1 = f2 = f3 = 1;
            t = i;
            while ( t != 0 )
            {
                f1 = f1 * t;
                t--;
            }

            t = j;
            while ( t != 0 )
            {
                f2 = f2 * t;
                t--;
            }

            t = i - j;

```



```
        while ( t != 0 )
        {
            f3 = f3 * t ;
            t-- ;
        }

        z = f1 / ( f2 * f3 ) ;
        printf ( " %4d ", z ) ;
    }
    printf ( "\n" ) ;
}

return 0 ;
}
```

CHAPTER

SEVEN

Case Control Instruction

[A] What will be the output of the following programs:

```
(a) #include <stdio.h>
int main( )
{
    char suite = 3 ;
    switch ( suite )
    {
        case 1 :
            printf ( "Diamond\n" ) ;
        case 2 :
            printf ( "Spade\n" ) ;
        default :
            printf ( "Heart\n" ) ;
    }
    printf ( "I thought one wears a suite\n" ) ;
    return 0 ;
}
```

Output:

Heart
I thought one wears a suite

```
(b) #include <stdio.h>
int main( )
{
    int c = 3 ;
    switch ( c )
    {
        case '3' :
            printf ( "You never win the silver prize\n" ) ;
            break ;
        case 3 :
            printf ( "You always lose the gold prize\n" ) ;
            break ;
        default :
            printf ( "Of course provided you win a prize\n" ) ;
    }
    return 0 ;
}
```

Output:

You always lose the gold prize

```
(c) #include <stdio.h>
int main( )
{
    int i = 3 ;
    switch ( i )
    {
        case 0 :
            printf ( "Customers are dicey\n" ) ;
        case 1 + 0 :
            printf ( "Markets are pricey\n" ) ;
        case 4 / 2 :
            printf ( "Investors are moody\n" ) ;
        case 8 % 5 :
            printf ( "At least employees are good\n" ) ;
    }
    return 0 ;
}
```

```
}
```

Output:

At least employees are good

```
(d) #include <stdio.h>
int main( )
{
    int k ;
    float j = 2.0 ;
    switch ( k = j + 1 )
    {
        case 3 :
            printf ( "Trapped\n" ) ;
            break ;
        default :
            printf ( "Caught!\n" ) ;
    }
    return 0 ;
}
```

Output:

Trapped

```
(e) #include <stdio.h>
int main( )
{
    int ch = 'a' + 'b' ;
    switch ( ch )
    {
        case 'a' :
        case 'b' :
            printf ( "You entered b\n" ) ;
        case 'A' :
            printf ( "a as in ashar\n" ) ;
        case 'b' + 'a' :
            printf ( "You entered a and b\n" ) ;
    }
```

```
    }  
    return 0 ;  
}
```

Output:

You entered a and b

```
(f) # include <stdio.h>  
int main( )  
{  
    int i = 1 ;  
    switch ( i - 2 )  
    {  
        case -1 :  
            printf ( "Feeding fish\n" ) ;  
        case 0 :  
            printf ( "Weeding grass\n" ) ;  
        case 1 :  
            printf ( "Mending roof\n" ) ;  
        default :  
            printf ( "Just to survive\n" ) ;  
    }  
    return 0 ;  
}
```

Output:

Feeding fish
Weeding grass
mending roof
Just to survive

[B] Point out the errors, if any, in the following programs:

```
(a) # include <stdio.h>  
int main( )  
{  
    int suite = 1 ;
```

```
switch ( suite ) ;
{
    case 0 ;
        printf ( "Club\n" ) ;
    case 1 ;
        printf ( "Diamond\n" ) ;
    }
    return 0 ;
}
```

Error. Semi-colon after *switch* statement and after *case 0* and *case 1*.

```
(b) #include <stdio.h>
int main( )
{
    int temp ;
    scanf ( "%d", &temp ) ;
    switch ( temp )
    {
        case ( temp <= 20 ) :
            printf ( "Oooooooooohhhh! Damn cool! \n" ) ;
        case ( temp > 20 && temp <= 30 ) :
            printf ( "Rain rain here again! \n" ) ;
        case ( temp > 30 && temp <= 40 ) :
            printf ( "Wish I am on Everest\n" ) ;
        default :
            printf ( "Good old nagpur weather\n" ) ;
    }
    return 0 ;
}
```

Error. Relational operators cannot be used in cases.

```
(c) #include <stdio.h>
int main( )
{
    float a = 3.5 ;
```

```
switch ( a )
{
    case 0.5 :
        printf ( "The art of C\ " );
        break ;
    case 1.5 :
        printf ( "The spirit of C\n" );
        break ;
    case 2.5 :
        printf ( "See through C\n" );
        break ;
    case 3.5 :
        printf ( "Simply c\n" );
    }
    return 0 ;
}
```

Error. Floats cannot be used in cases.

```
(d) # include <stdio.h>
int main( )
{
    int a = 3, b = 4, c ;
    c = b - a ;
    switch ( c )
    {
        case 1 || 2 :
            printf ( "God give me a chance to change things\n" );
            break ;

        case a || b :
            printf ( "God give me chance to run my show\n" );
            break ;
    }
    return 0 ;
}
```

Error. A case needs a constant expression. Logical operators cannot be used in cases.

[C] Write a menu driven program which has following options:

1. Factorial of a number
2. Prime or not
3. Odd or even
4. Exit

Once a menu item is selected the appropriate action should be taken and once this action is finished, the menu should reappear. Unless the user selects the 'Exit' option the program should continue to work.

Hint: Make use of an infinite **while** and a **switch** statement.

Program:

```
/* Menu driven program */
#include <stdio.h>

int main( )
{
    int choice, num, i ;
    unsigned long int fact ;

    while ( 1 )
    {
        printf ( "\n\n1. Factorial\n" );
        printf ( "2. Prime\n" );
        printf ( "3. Odd / Even\n" );
        printf ( "4. Exit\n" );

        printf ( "\nYour choice ? " );
        scanf ( "%d", &choice );

        switch ( choice )
```



```
{
    case 1 :
        printf ( "\nEnter number: " );
        scanf ( "%d", &num );

        fact = 1 ;
        for ( i = 1 ; i <= num ; i++ )
            fact = fact * i ;
        printf ( "Factorial value = %lu\n", fact ) ;
        break ;

    case 2 :
        printf ( "\nEnter number: " );
        scanf ( "%d", &num );

        for ( i = 2 ; i < num ; i++ )
        {
            if ( num % i == 0 )
            {
                printf ( "Not a prime number\n" ) ;
                break ;
            }
        }
        if ( i == num )
            printf ( "\nPrime number" ) ;
        break ;

    case 3 :
        printf ( "\nEnter number: " );
        scanf ( "%d", &num );

        if ( num % 2 == 0 )
            printf ( "Even number\n" ) ;
        else
            printf ( "Odd number\n" ) ;
        break ;

    case 4 :
```

```
        exit ( 0 ); /* Terminates program execution */
    }
}
return 0 ;
}
```

[D] Write a program which to find the grace marks for a student using **switch**. The user should enter the class obtained by the student and the number of subjects he has failed in. Use the following logic:

- If the student gets first class and the number of subjects he failed in is greater than 3, then he does not get any grace. Otherwise the grace is of 5 marks per subject.
- If the student gets second class and the number of subjects he failed in is greater than 2, then he does not get any grace. Otherwise the grace is of 4 marks per subject.
- If the student gets third class and the number of subjects he failed in is greater than 1, then he does not get any grace. Otherwise the grace is of 5 marks.

Program:

```
/* Determine the grace marks obtained by student */
#include <stdio.h>

int main( )
{
    int c, sub ;

    printf ( "\nEnter the class and number of subjects failed: " ) ;
    scanf ( "%d %d", &c, &sub ) ;

    switch ( c )
    {
        case 1 :
```

```
        if ( sub <= 3 )
            printf ( "Student gets total of %d grace marks\n",
                    5 * sub );
        else
            printf ( "No grace marks\n" );
        break ;

    case 2 :
        if ( sub <= 2 )
            printf ( "Student gets total of %d grace marks\n",
                    4 * sub );
        else
            printf ( "No grace marks\n" );
        break ;

    case 3 :
        if ( sub == 1 )
            printf ( "Student gets 5 grace marks\n" );
        else
            printf ( "No grace marks\n" );
        break ;

    default :
        printf ( "Wrong class entered\n" );
}

return 0 ;
}
```

CHAPTER EIGHT

Functions

[A] What will be the output of the following programs:

(a)

```
#include <stdio.h>
void display( ) ;
int main( )
{
    printf ( "Learn C\n" ) ;
    display( ) ;
    return 0 ;
}
void display( )
{
    printf ( "Followed by C++, C# and Java!\n" ) ;
    main( ) ;
}
```

Output:

Both the messages will get printed indefinitely

(b)

```
#include <stdio.h>
int check ( int ) ;
int main( )
{
    int i = 45, c ;
    c = check ( i ) ;
```

```
    printf ( "%d\n", c );
    return 0 ;
}
int check ( int ch )
{
    if ( ch >= 45 )
        return ( 100 ) ;
    else
        return ( 10 * 10 ) ;
}
```

Output:

100

```
(c) # include <stdio.h>
    float circle ( int ) ;
    int main( )
    {
        float area ;
        int radius = 1 ;
        area = circle ( radius ) ;
        printf ( "%f\n", area ) ;
        return 0 ;
    }
    float circle ( int r )
    {
        float a ;
        a = 3.14 * r * r ;
        return ( a ) ;
    }
```

Output:

3.000000

```
(d) # include <stdio.h>
    int main( )
    {
```

```
void slogan( );
int c = 5 ;
c = slogan( ) ;
printf ( "%d\n", c ) ;
return 0 ;
}
void slogan( )
{
    printf ( "Only He men use C!\n" ) ;
}
```

Output:

Error message by compiler

[B] Point out the errors, if any, in the following programs:

```
(a) #include <stdio.h>
int addmult ( int, int )
int main( )
{
    int i = 3, j = 4, k, l ;
    k = addmult ( i, j ) ;
    l = addmult ( i, j ) ;
    printf ( "%d %d\n", k, l ) ;
    return 0 ;
}
int addmult ( int ii, int jj )
{
    int kk, ll ;
    kk = ii + jj ;
    ll = ii * jj ;
    return ( kk, ll ) ;
}
```

Error. Missing ; in prototype declaration of **addmult()**. Also, a function cannot return 2 values at a time.

```
(b) #include <stdio.h>
void message( );
int main( )
{
    int a;
    a = message( );
    return 0;
}
void message( )
{
    printf ( "Viruses are written in C\n" );
    return ;
}
```

No Error. But since no value is being returned there is no need to collect it in variable **a**.

```
(c) #include <stdio.h>
int main( )
{
    float a = 15.5;
    char ch = 'C';
    printit ( a, ch );
    return 0;
}
printit ( a, ch )
{
    printf ( "%f %c\n", a, ch );
}
```

Error. **a** and **ch** should be declared as **float** and **char** respectively in the function **printit()**.

```
(d) #include <stdio.h>
void message( );
int main( )
{
    message( );
}
```

```
    message( ) ;  
    return 0 ;  
}  
void message( ) ;  
{  
    printf ( "Praise worthy and C worthy are synonyms\n" ) ;  
}
```

Error. Semicolon shouldn't be present immediately after **message()** in the function definition.

```
(e) #include <stdio.h>  
int main( )  
{  
    let_us_c( )  
    {  
        printf ( "C is a Cimple minded language !\n" ) ;  
        printf ( "Others are of course no match !\n" ) ;  
    }  
    return 0 ;  
}
```

Error. One function cannot be defined within another function.

```
(f) #include <stdio.h>  
void message( ) ;  
int main( )  
{  
    message ( message( ) ) ;  
    return 0 ;  
}  
void message( )  
{  
    printf ( "It's a small world after all...\n" ) ;  
}
```


Error. **void** returned by inner call to **message()** cannot be passed to the outer call.

[C] Answer the following:

(a) Is this a correctly written function:

```
int sqr ( int a );  
{  
    return ( a * a );  
}
```

Answer:

No. Semicolon shouldn't be present immediately after **sqr()**.

(b) State whether the following statements are True or False:

(1) The variables commonly used in C functions are available to all the functions in a program.

Answer: False

(2) To return the control back to the calling function we must use the keyword **return**.

Answer: False

(3) The same variable names can be used in different functions without any conflict.

Answer: True

(4) Every called function must contain a **return** statement.

Answer: False

(5) A function may contain more than one **return** statements.

Answer: True

- (6) Each **return** statement in a function may return a different value.

Answer: True

- (7) A function can still be useful even if you don't pass any arguments to it and the function doesn't return any value back.

Answer: True

- (8) Same names can be used for different functions without any conflict.

Answer: False

- (9) A function may be called more than once from any other function.

Answer: True

- (10) It is necessary for a function to return some value.

Answer: False

[D] Answer the following:

- (a) Write a function to calculate the factorial value of any integer entered through the keyboard.

Program:

```
/* Calculate factorial value of an integer using a function */
#include <stdio.h>

long fact ( int );
int main( )
{
    int num ;
    long factorial ;
```

```
printf ( "\nEnter a number: " );
scanf ( "%d", &num );

factorial = fact ( num );
printf ( "Factorial of %d = %ld\n", num, factorial );

return 0 ;
}

long fact ( int num )
{
    int i ;
    long factorial = 1 ;

    for ( i = 1 ; i <= num ; i++ )
        factorial = factorial * i ;
    return ( factorial ) ;
}
```

- (b) Write a function **power (a, b)**, to calculate the value of **a** raised to **b**.

Program:

```
/* Program to calculate power of a value */
#include <stdio.h>

long power ( int, int );
int main( )
{
    int x, y ;
    long pow ;

    printf ( "\nEnter two numbers: " );
    scanf ( "%d %d", &x, &y );
```

```

    pow = power ( x , y ) ; /* Function call */
    printf ( "%d to the power %d = %d\n", x, y, pow ) ;

    return 0 ;
}

long power ( int x, int y )
{
    int i ;
    long p = 1 ;

    for ( i = 1 ; i <= y ; i++ )
        p = p * x ;
    return ( p ) ;
}

```

- (c) Write a general-purpose function to convert any given year into its roman equivalent. Use these roman equivalents for decimal numbers: 1 – I, 5 – V, 10 – X, 50 – L, 100 – C, 500 – D, 1000 – M.

Example:

Roman equivalent of 1988 is mdcccclxxxviii

Roman equivalent of 1525 is mdxxv

Program:

```

/* Convert given year into its roman equivalent */
#include <stdio.h>

int romanise ( int, int, char ) ;
int main ( )
{
    int yr ;

    printf ( "\nEnter year: " ) ;
    scanf ( "%d", &yr ) ;
}

```

```
    yr = romanise ( yr, 1000, 'm' ) ; /* Series of function calls */
    yr = romanise ( yr, 500, 'd' ) ;
    yr = romanise ( yr, 100, 'c' ) ;
    yr = romanise ( yr, 50, 'l' ) ;
    yr = romanise ( yr, 10, 'x' ) ;
    yr = romanise ( yr, 5, 'v' ) ;
    yr = romanise ( yr, 1, 'i' ) ;

    return 0 ;
}

int romanise ( int y, int k, char ch )
{
    int i, j ;

    if ( y == 9 )
    {
        printf ( "ix" ) ;
        return ( y % 9 ) ;
    }

    if ( y == 4 )
    {
        printf ( "iv" ) ;
        return ( y % 4 ) ;
    }

    j = y / k ;

    for ( i = 1 ; i <= j ; i++ )
        printf ( "%c", ch ) ;

    return ( y - k * j ) ;
}
```

- (d) Any year is entered through the keyboard. Write a function to determine whether the year is a leap year or not.

Program:

```
/* Using a function, determine whether a year is leap year or not */  
#include <stdio.h>
```

```
void leapyear ( int ) ;  
int main( )  
{  
    int year ;  
  
    printf ( "\nEnter year: " ) ;  
    scanf ( "%d", &year ) ;  
  
    leapyear ( year ) ; /* Function call */  
  
    return 0 ;  
}  
  
void leapyear ( int year )  
{  
    if ( year % 4 == 0 && year % 100 != 0 || year % 400 == 0 )  
        printf ( "%d is leap year\n", year ) ;  
    else  
        printf ( "%d is not a leap year\n", year ) ;  
}
```

- (e) A positive integer is entered through the keyboard. Write a function to obtain the prime factors of this number.

For example, prime factors of 24 are 2, 2, 2 and 3, whereas prime factors of 35 are 5 and 7.

Program:

```
/* Obtain prime factors of a number */  
#include <stdio.h>
```

```
void prime ( int ) ;
```

```
int main( )
{
    int num ;

    printf ( "Enter number:" ) ;
    scanf ( "%d", &num ) ;

    prime ( num ) ; /* Function call */

    return 0 ;
}

void prime ( int num )
{
    int i = 2 ;
    printf ( "Prime factors of %d are ", num ) ;

    while ( num != 1 )
    {
        if ( num % i == 0 )
            printf ( "%d ", i ) ;
        else
        {
            i++ ;
            continue ;
        }
        num = num / i ;
    }
}
```

CHAPTER NINE

Pointers

[A] What will be the output of the following programs:

(a)

```
#include <stdio.h>
void fun ( int, int );
int main( )
{
    int i = 5, j = 2 ;
    fun ( i, j );
    printf ( "%d %d\n", i, j );
    return 0 ;
}
void fun ( int i, int j )
{
    i = i * i ;
    j = j * j ;
}
```

Output:

5 2

(b)

```
#include <stdio.h>
void fun ( int *, int * );
int main( )
{
    int i = 5, j = 2 ;
    fun ( &i, &j );
}
```



```

        printf ( "%d %d\n", i, j ) ;
        return 0 ;
    }
    void fun ( int *i, int *j )
    {
        *i = *i * *i ;
        *j = *j * *j ;
    }

```

Output:

25 4

```

(c) # include <stdio.h>
    int main( )
    {
        float a = 13.5 ;
        float *b, *c ;
        b = &a ; /* suppose address of a is 1006 */
        c = b ;
        printf ( "%u %u %u\n", &a, b, c ) ;
        printf ( "%f %f %f %f %f\n", a, *(&a), *&a, *b, *c ) ;
        return 0 ;
    }

```

Output:

1006 1006 1006
 13.500000 13.500000 13.500000 13.500000 13.500000
 Note : Instead of 1006 you may get some other number

[B] Point out the errors, if any, in the following programs:

```

(a) # include <stdio.h>
    void pass ( int, int ) ;
    int main( )
    {
        int i = 135, a = 135, k ;
        k = pass ( i, a ) ;
    }

```

```
        printf ( "%d\n", k );
        return 0 ;
    }
    void pass ( int j, int b )
    int c ;
    {
        c = j + b ;
        return ( c ) ;
    }
```

Error. The declaration **int c** should be made inside the brace.

```
(b) #include <stdio.h>
void jiaayjo ( int, int )
int main( )
{
    int p = 23, f = 24 ;
    jiaayjo ( &p, &f ) ;
    printf ( "%d %d\n", p, f ) ;
    return 0 ;
}
void jiaayjo ( int q, int g )
{
    q = q + q ;
    g = g + g ;
}
```

Error. Missing **;** and **q** and **g** should be declared as integer pointers.

```
(c) #include <stdio.h>
void check ( int ) ;
int main( )
{
    int k = 35, z ;
    z = check ( k ) ;
    printf ( "%d\n", z ) ;
    return 0 ;
}
```

```
}  
void check ( m )  
{  
    int m ;  
    if ( m > 40 )  
        return ( 1 ) ;  
    else  
        return ( 0 ) ;  
}
```

Error. The declaration **int m** should be before the opening brace.

```
(d) #include <stdio.h>  
void function ( int * ) ;  
int main( )  
{  
    int i = 35, *z ;  
    z = function ( &i ) ;  
    printf ( "%d\n", z ) ;  
    return 0 ;  
}  
void function ( int *m )  
{  
    return ( m + 2 ) ;  
}
```

Error. Not an allowed type.

[C] Attempt the following:

- (a) Write a function that receives 5 integers and returns the sum, average and standard deviation of these numbers. Call this function from **main()** and print the results in **main()**.

Program:

```
/* Function which returns sum, average and standard deviation */
```

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

void function ( int *, int *, double * );
int main( )
{
    int sum, avg ;
    double stdev ;

    function ( &sum, &avg, &stdev ) ; /* Function call by reference */
    printf ( "Sum = %d \nAverage = %d \nStandard deviation = %f\n",
            sum, avg, stdev ) ;

    return 0 ;
}

void function ( int *sum, int *avg, double *stdev )
{
    int n1, n2, n3, n4, n5 ;

    printf ( "\nEnter 5 numbers: " ) ;
    scanf ( "%d%d%d%d%d", &n1, &n2, &n3, &n4, &n5 ) ;

    *sum = n1 + n2 + n3 + n4 + n5 ; /* Calculate sum */
    *avg = *sum / 5 ; /* Calculate average */
    /* Calculate standard deviation */
    *stdev = sqrt ( ( pow ( ( n1 - *avg ), 2) + pow ( ( n2 - *avg ), 2) +
                    pow ( ( n3 - *avg ), 2) + pow ( ( n4 - *avg ), 2) +
                    pow ( ( n5 - *avg ), 2 ) ) / 4 ) ;
}
```

- (b) Write a function that receives marks received by a student in 3 subjects and returns the average and percentage of these marks. Call this function from **main()** and print the results in **main()**.

Program:

```
/* Function which returns average and percentage */
#include <stdio.h>

void result ( int, int, int, float *, float * );
int main( )
{
    float avg, per ;
    int m1, m2, m3 ;

    printf ( "Enter marks of three subjects: " ) ;
    scanf ( "%d %d %d", &m1, &m2, &m3 ) ;
    result ( m1, m2, m3, &avg, &per ) ;
    printf ( "Average = %f \nPercentage = %f\n", avg, per ) ;

    return 0 ;
}

void result ( int m1, int m2, int m3, float *a, float *p )
{
    *p = *a = ( m1 + m2 + m3 ) / 3.0f ;
}
```

(c) Write a C function to evaluate the series

$$\sin(x) = x - (x^3 / 3!) + (x^5 / 5!) - (x^7 / 7!) + \dots$$

to five significant digits.

Program:

```
/* Evaluation of a series */
#include <stdio.h>
#include <math.h>

float numerator ( float, int ) ;
float denominator ( int ) ;
int main( )
```

```
{
    float n, x, a, b, sum = 0 ;
    int i, j ;

    printf ( "\nEnter the number x: " );
    scanf ( "%f", &x );
    for ( i = 1, j = 1 ; i <= 10 ; i++, j += 2 ) /* upto 10 terms */
    {
        a = numerator ( x, j );
        b = denominator ( j );
        n = a / b ;
        ( i % 2 == 0 ) ? sum = sum - n : ( sum = sum + n );
    }
    printf ( "sum = %f\n", sum );

    return 0 ;
}

/* Calculate Power */
float numerator ( float y, int j )
{
    float k = 1 ;
    int m ;

    for ( m = 1 ; m <= j ; m++ )
        k *= y ;

    return ( k );
}

/* Calculate factorial */
float denominator ( int j )
{
    int m ;
    float h = 1 ;

    for ( m = 1 ; m <= j ; m++ )
        h = h * m ;
}
```

```
    return ( h );  
}
```

- (d) Given three variables **x**, **y**, **z** write a function to circularly shift their values to right. In other words if $x = 5$, $y = 8$, $z = 10$, after circular shift $y = 5$, $z = 8$, $x = 10$. Call the function with variables **a**, **b**, **c** to circularly shift values.

Program:

```
/* Circular shifting of values */  
#include <stdio.h>  
  
void fun ( int, int, int );  
int main( )  
{  
    int x, y, z ;  
  
    printf ( "Enter the values x, y, z:\n" );  
    scanf ( "%d%d%d", &x, &y, &z );  
    printf ( "\nValues of x, y & z as entered:" );  
    printf ( "\nx = %d\ty = %d\tz = %d\n", x, y, z );  
    fun ( x, y, z );  
  
    return 0 ;  
}  
  
/* Function to shift values of x, y & z */  
void fun ( int x, int y, int z )  
{  
    int i, t ;  
    for ( i = 0 ; i <= 2 ; i++ )  
    {  
        t = z ;  
        z = y ;  
        y = x ;
```

```

        x = t ;
        printf ( "\n\nAfter right shifting of values %d time(s):\n", i + 1 ) ;
        printf ( "x = %d\ty = %d\tz = %d", x, y, z ) ;
    }
}

```

- (e) If the lengths of the sides of a triangle are denoted by **a**, **b**, and **c**, then area of triangle is given by

$$area = \sqrt{S(S-a)(S-b)(S-c)}$$

where, $S = (a + b + c) / 2$. Write a function to calculate the area of the triangle.

Program:

```

/* Area of triangle with sides a, b & c */
# include <stdio.h>
# include <math.h>

float area ( float a, float b, float c ) ;
int main ( )
{
    float a, b, c, z ;

    printf ( "\nEnter three sides of the triangle: " ) ;
    scanf ( "%f%f%f", &a, &b, &c ) ;
    z = area ( a, b, c ) ;
    printf ( "\n\nArea of the triangle = %.3f\n", z ) ;
    return 0 ;
}

/* Function to calculate area from a formula */
float area ( float a, float b, float c )
{
    float s, m, x ;
    s = ( a + b + c ) / 2 ;

```



```

    m = s * ( s - a ) * ( s - b ) * ( s - c );
    x = sqrt ( m );

    return ( x );
}

```

- (f) Write a function to compute the distance between two points and use it to develop another function that will compute the area of the triangle whose vertices are **A(x1, y1)**, **B(x2, y2)**, and **C(x3, y3)**. Use these functions to develop a function which returns a value 1 if the point (x, y) lies inside the triangle ABC, otherwise returns a value 0.

Program:

```

/* Calculate distance between two points and use the function
   to calculate area of triangle given its three vertices */
# include <stdio.h>
# include <math.h>

float distance ( int x1, int y1, int x2, int y2 ) ;
float area( ) ;

int main( )
{
    int x1, x2, y1, y2 ;
    float z, x ;

    printf ( "\nEnter the co-ordinates of two points: " ) ;
    scanf ( "%d%d%d%d", &x1, &y1, &x2, &y2 ) ;
    z = distance ( x1, y1, x2, y2 ) ;
    printf ( "\nDistance between Two points = %f\n", z ) ;

    x = area( ) ;
    printf ( "\nArea of the triangle = %f\n", x ) ;

    return 0 ;
}

```

```
}

/* Function to calculate distance */
float distance ( int x1, int y1, int x2, int y2 )
{
    float m, d ;
    m = pow ( ( x2 - x1 ), 2 ) + pow ( ( y2 - y1 ), 2 ) ;
    d = sqrt ( m ) ;
    return d ;
}

/* Get vertices of triangle */
float area( )
{
    float triarea ( float, float, float ) ;
    float a, b, c, d ;
    int x1, x2, x3, x4, y1, y2, y3, y4 ;
    float area1, area2, area3, totarea ;
    float a1, b1, c1 ;

    printf ( "\nEnter the co-ordinates of three points: " ) ;
    scanf ( "%d%d%d%d%d", &x1, &y1, &x2, &y2, &x3, &y3 ) ;
    printf ( "\nEnter the co-ordinates of one more point: " ) ;
    scanf ( "%d%d", &x4, &y4 ) ;

    a = distance ( x1, y1, x2, y2 ) ;
    b = distance ( x1, y1, x3, y3 ) ;
    c = distance ( x2, y2, x3, y3 ) ;
    d = triarea ( a, b, c ) ;
    a1 = distance ( x1, y1, x4, y4 ) ;
    b1 = distance ( x2, y2, x4, y4 ) ;
    c1 = distance ( x3, y3, x4, y4 ) ;

    area1 = triarea ( a, a1, b1 ) ;
    area2 = triarea ( b, a1, c1 ) ;
    area3 = triarea ( c, b1, c1 ) ;
    totarea = area1 + area2 + area3 ;
```

```

    if ( ( totarea - d ) <= 0.0009 )
    /* 0.0009 used to counter the anomaly in floating point
       calculations */
        printf ( "\nPoint ( %d, %d ) is inside the Triangle\n", x4, y4 ) ;
    else
        printf ( "\nPoint ( %d, %d ) lies outside the Triangle\n", x4, y4 ) ;

    return d ;
}

/* Function to calculate area from a formula */
float triarea ( float a, float b, float c )
{
    float s, m, x ;
    s = ( a + b + c ) / 2 ;
    m = s * ( s - a ) * ( s - b ) * ( s - c ) ;
    x = sqrt ( m ) ;
    return ( x ) ;
}

```

- (g) Write a function to compute the greatest common divisor given by Euclid's algorithm, exemplified for $J = 1980$, $K = 1617$ as follows:

$1980 / 1617 = 1$	$1980 - 1 * 1617 = 363$
$1617 / 363 = 4$	$1617 - 4 * 363 = 165$
$363 / 165 = 2$	$363 - 2 * 165 = 33$
$5 / 33 = 5$	$165 - 5 * 33 = 0$

Thus, the greatest common divisor is 33.

Program:

```

/* Compute Greatest common divisor - Euclid's Algorithm */
#include <stdio.h>

int fun ( int, int ) ;
int main( )
{

```

```
int j, k, t, r, z ;

printf ( "\nEnter two numbers: " );
scanf ( "%d%d", &j, &k );
z = fun ( j, k );
printf ( "Greatest common divisor of the two numbers is %d\n", z );
return 0 ;
}

/* Function to calculate GCD */
int fun ( int j, int k )
{
    int r = 1, m, n = 0, t ;
    if ( k > j ) /* Interchange values */
    {
        t = j ;
        j = k ;
        k = t ;
    }
    else
    {
        if ( j == k )
            return j ;
    }
    while ( 1 )
    {
        r = j / k ;
        m = j - ( r * k ) ;

        if ( ! ( j % k ) ) /* j is exact multiple of k */
            n = k ;

        if ( m == 0 )
            break ;

        j = k ;
        k = m ;
        n = m ;
    }
}
```

```
    }  
    return n ;  
}
```

CHAPTER

Ten

Recursion

[A] What will be the output of the following programs:

(a)

```
#include <stdio.h>
int main( )
{
    printf ( "C to it that C survives\n" );
    main( ) ;
    return 0 ;
}
```

Output:

The message will get printed indefinitely.

(b)

```
#include <stdio.h>
int main( )
{
    int i = 0 ;
    i++ ;
    if ( i <= 5 )
    {
        printf ( "C adds wings to your thoughts\n" ) ;
        exit ( 0 ) ;
        main( ) ;
    }
    return 0 ;
}
```

Output:

C adds wings to your thoughts

[B] Attempt the following:

- (a) A 5-digit positive integer is entered through the keyboard, write a recursive and a non-recursive function to calculate sum of digits of the 5-digit number.

Program:

```
/* Calculate sum of digits of a five-digit number with/without recursion */
#include <stdio.h>

int sum ( int ); /* Function without recursion */
int rsum ( int ); /* Function with recursion */
int main( )
{
    int s, rs ;
    int n ;

    printf ( "Enter number" ) ;
    scanf ( "%d", &n ) ;

    s = sum ( n ) ; /* Function call without recursion */
    printf ( "Sum digits without using recursion is %d\n", s ) ;
    rs = rsum ( n ) ; /* Function call with recursion */
    printf ( "Sum of digits using recursion is %d\n", rs ) ;

    return 0 ;
}

int sum ( int num ) /* Function without recursion */
{
    int remainder, sum = 0 ;

    /* This time our code is very short because we can now use a while"
```

```
        clause which was not used in the earlier instance of this program */

while ( num > 0 )
{
    remainder = num % 10 ; /* Calculate remainder */
    sum = sum + remainder ; /* update sum */
    num = num / 10 ; /* Remove last digit */
}

return ( sum ) ;
}

int rsum ( int num ) /* Function with recursion */
{
    int sum = 0 ;
    int remainder ;

    if ( num != 0 )
    {
        remainder = num % 10 ; /* Calculate remainder */
        sum = remainder + rsum( num / 10 ) ; /* Recursive call */
    }

    return sum ;
}
```

- (b) A positive integer is entered through the keyboard, write a program to obtain the prime factors of the number. Modify the function suitably to obtain the prime factors recursively.

Program:

```
/* Find Prime Factors of a number recursively */
#include <stdio.h>

void factor ( int ) ;
int main( )
```



```
{
    int num ;

    printf ( "Enter a number" ) ;
    scanf ( "%d", &num ) ;

    printf ( "Prime factors are:" ) ;
    factor ( num ) ;
    return 0 ;
}

void factor ( int n )
{
    static int i = 2 ;

    if ( i <= n )
    {
        if ( n % i == 0 )
        {
            printf ( "%d ", i ) ;
            n = n / i ;
        }
        else
            i++ ;

        factor ( n ) ; /* Recursive call */
    }
    return ;
}
```

- (c) Write a recursive function to obtain the first 25 numbers of a Fibonacci sequence. In a Fibonacci sequence the sum of two successive terms gives the third term. Following are the first few terms of the Fibonacci sequence:

1 1 2 3 5 8 13 21 34 55 89....

Program:

```
/* Generate first 25 terms of a fibonacci sequence */
#include <stdio.h>

void fibo ( int, int ) ;
int main( )
{
    int i, t, old = 0, current = 1, new ;

    printf ( "%d\t%d\t", old, current ) ;
    fibo ( old, current ) ;

    return 0 ;
}

void fibo ( int old, int current )
{
    static int terms = 2 ;
    int new ;

    if ( terms < 20 )
    {
        new = old + current ;

        printf ( "%d\t", new ) ;
        terms = terms + 1 ;
        fibo ( current, new ) ;
    }
    else
        return ;
}
```

- (d) A positive integer is entered through the keyboard, write a function to find the binary equivalent of this number :

- (1) Without using recursion
- (2) Using recursion

Program:

```
/* Binary equivalent of a decimal number */
# include <stdio.h>

int binary ( int );
int main( )
{
    int num ;

    printf ( "\nEnter the number: " );
    scanf ( "%d", &num );

    binary ( num ); /* Function call */

    return 0 ;
}

/* function to convert decimal to binary */
int binary ( int n )
{
    int r ;

    r = n % 2 ;
    n = n / 2 ;
    if ( n == 0 )
    {
        printf ( "\nThe binary equivalent is %d", r );
        return ( r );
    }
    else
        binary ( n ); /* Recursive call */
    printf ( "%d", r );
}
```

- (e) Write a recursive function to obtain the running sum of first 25 natural numbers.

Program:

```
/* Program to obtain running sum of natural numbers */
#include <stdio.h>

int getsum ( int );
int main()
{
    int s;

    s = getsum ( 0 );
    printf ( "The sum of first 25 natural numbers is %d\n", s );

    return 0 ;
}

int getsum ( int n )
{
    int sum = 0 ;
    if ( n == 25 )
        return sum ;

    sum = n + getsum ( ++n );
    return ( sum );
}
```


CHAPTER

ELEVEN

Data Types Revisited

[A] What will be the output of the following programs:

(a)

```
#include <stdio.h>
int main( )
{
    int i ;
    for ( i = 0 ; i <= 50000 ; i++ )
        printf ( "%d\n", i ) ;
    return 0 ;
}
```

Output:

0
1
..
..
50000

(b)

```
#include <stdio.h>
int main( )
{
    float a = 13.5 ;
    double b = 13.5 ;
    printf ( "%f %lf\n", a, b ) ;
    return 0 ;
}
```

Output:

13.500000 13.500000

```
(c) #include <stdio.h>
int i = 0 ;
void val() ;
int main( )
{
    printf ( "main's i = %d\n", i ) ;
    i++ ;
    val() ;
    printf ( "main's i = %d\n", i ) ;
    val() ;
    return 0 ;
}
void val( )
{
    i = 100 ;
    printf ( "val's i = %d\n", i ) ;
    i++ ;
}
```

Output:

main's i = 0
val's i = 100
main's i = 101
val's i = 100

```
(d) #include <stdio.h>
int f ( int ) ;
int g ( int ) ;
int main( )
{
    int x, y, s = 2 ;
    s *= 3 ;
    y = f ( s ) ;
    x = g ( s ) ;
}
```

```
        printf ( "%d %d %d\n", s, y, x );
        return 0 ;
    }
    int t = 8 ;

    int f ( int a )
    {
        a += -5 ;
        t -= 4 ;
        return ( a + t ) ;
    }
    int g ( int a )
    {
        a = 1 ;
        t += a ;
        return ( a + t ) ;
    }
}
```

Output:

6 5 6

```
(e) #include <stdio.h>
int main ( )
{
    static int count = 5 ;
    printf ( "count = %d\n", count-- ) ;
    if ( count != 0 )
        main ( ) ;
    return 0 ;
}
```

Output:

count = 5
count = 4
count = 3
count = 2
count = 1


```
(f) #include <stdio.h>
int g ( int );
int main( )
{
    int i, j;
    for ( i = 1 ; i < 5 ; i++ )
    {
        j = g ( i );
        printf ( "%d\n", j );
    }
    return 0 ;
}
int g ( int x )
{
    static int v = 1 ;
    int b = 3 ;
    v += x ;
    return ( v + x + b );
}
```

Output:

6
9
13
18

```
(g) #include <stdio.h>
int main( )
{
    func( ) ;
    func( ) ;
    return 0 ;
}
void func( )
{
    auto int i = 0 ;
    register int j = 0 ;
```

```
static int k = 0 ;
i++ ; j++ ; k++ ;
printf ( "%d %d %d\n", i, j, k ) ;
}
```

Output:

```
1 1 1
1 1 2
```

```
(h) #include <stdio.h>
int x = 10 ;
int main( )
{
    int x = 20 ;
    {
        int x = 30 ;
        printf ( "%d\n", x ) ;
    }
    printf ( "%d\n", x ) ;
    return 0 ;
}
```

Output:

```
30
20
```

[B] Point out the errors, if any, in the following programs:

```
(a) #include <stdio.h>
int main( )
{
    long num ;
    num = 2 ;
    printf ( "%d\n", num ) ;
    return 0 ;
}
```

No Error

(b)

```
#include <stdio.h>
int main( )
{
    char ch = 200 ;
    printf ( "%d\n", ch ) ;
    return 0 ;
}
```

No Error

(c)

```
#include <stdio.h>
int main( )
{
    unsigned a = 25 ;
    long unsigned b = 25l ;
    printf ( "%lu %u\n", a, b ) ;
    return 0 ;
}
```

Error. Format %lu should be used for b and %u should be used for a.

(d)

```
#include <stdio.h>
int main( )
{
    long float a = 25.345e454 ;
    unsigned double b = 25 ;
    printf ( "%lf %d\n", a, b ) ;
    return 0 ;
}
```

Error. Format %lf should be used for b.

(e)

```
#include <stdio.h>
static int y ;
int main( )
{
    static int z ;
    printf ( "%d %d\n", y, z ) ;
    return 0 ;
}
```

}

No Error

[C] State whether the following statements are True or False:

- (a) Storage for a register storage class variable is allocated each time the control reaches the block in which it is present.

Answer: True

- (b) An extern storage class variable is not available to the functions that precede its definition, unless the variable is explicitly declared in these functions.

Answer: True

- (c) The value of an automatic storage class variable persists between various function invocations.

Answer: False

- (d) If the CPU registers are not available, the register storage class variables are treated as static storage class variables.

Answer: False

- (e) The register storage class variables cannot hold float values.

Answer: True

- (f) If we try to use register storage class for a **float** variable the compiler will report an error message.

Answer: False

- (g) If the variable **x** is defined outside all functions and a variable **x** is also defined as a local variable of some function, then the global variable gets preference over the local variable.

Answer: False

- (h) The default value for automatic variable is zero.

Answer: False

- (i) The life of static variable is till the control remains within the block in which it is defined.

Answer: False

- (j) If a global variable is to be defined, then the **extern** keyword is necessary in its declaration.

Answer: False

- (k) The address of register variable is not accessible.

Answer: True

- (l) A variable that is defined outside all functions can also have a static **storage** class.

Answer: True

- (m) One variable can have multiple storage classes.

Answer: False

CHAPTER

TWELVE

The C Preprocessor

[A] Answer the following:

(a) A preprocessor directive is:

1. a message from compiler to the programmer
2. a message from compiler to the linker
3. a message from programmer to the preprocessor
4. a message from programmer to the microprocessor

Answer:

(3) a message from programmer to the preprocessor

(b) Which of the following are correctly formed **#define** statements:

```
#define INCH PER FEET 12
#define SQR (X) ( X * X )
#define SQR(X) X * X
#define SQR(X) ( X * X )
```

Answer:

```
#define SQR(X) ( X * X )
```

(c) State True or False:

- (1) A macro must always be written in capital letters.

Answer: False

- (2) A macro should always be accommodated in a single line.

Answer: Usually true. Some compilers allow multi-line macros

- (3) After preprocessing when the program is sent for compilation the macros are removed from the expanded source code.

Answer: True

- (4) Macros with arguments are not allowed.

Answer: False

- (5) Nested macros are allowed.

Answer: False

- (6) In a macro call the control is passed to the macro.

Answer: False

- (d) How many **#include** directives can be there in a given program file?

Answer:

As many as you desire

- (e) What is the difference between the following two **#include** directives:

```
#include "conio.h"  
#include <conio.h>
```

Answer:

#include “conio.h”: This command would look for the file conio.h in the current directory as well as the specified list of directories as mentioned in the search path that might have been set up.

#include<conio.h>: This command would look for the file conio.h in the specified list of directories only.

(f) A header file is:

1. A file that contains standard library functions
2. A file that contains definitions and macros
3. A file that contains user-defined functions
4. A file that is present in current working directory

Answer:

(2) A file that contains definitions and macros

(g) Which of the following is not a preprocessor directive

1. #if
2. #elseif
3. #undef
4. #pragma

Answer:

(2) #elseif

(h) All macro substitutions in a program are done

1. Before compilation of the program

2. After compilation
3. During execution
4. None of the above

Answer:

(1) Before compilation of the program

- (i) In a program the statement:

```
#include "filename"
```

is replaced by the contents of the file “filename”

1. Before compilation
2. After Compilation
3. During execution
4. None of the above

Answer:

(1) Before compilation

[B] What will be the output of the following programs:

- (a)

```
#include <stdio.h>
int main( )
{
    int i = 2 ;
    # ifdef DEF
        i *= i ;
    # else
        printf ( "%d\n", i ) ;
    # endif
    return 0 ;
}
```

Output:

2

```
(b) #include <stdio.h>
# define PRODUCT(x) ( x * x )
int main( )
{
    int i = 3, j, k, l;
    j = PRODUCT( i + 1 );
    k = PRODUCT( i++ );
    l = PRODUCT ( ++i );
    printf ( "%d %d %d %d %d\n", i, j, k, l );
    return 0 ;
}
```

Output:

7 7 9 49

```
(c) #include <stdio.h>
# define PI 3.14
# define AREA( x, y, z ) ( PI * x * x + y * z );

int main( )
{
    float a = AREA ( 1, 5, 8 );
    float b = AREA ( AREA ( 1, 5, 8 ), 4, 5 );
    printf ( " a = %f\n", a );
    printf ( " b = %f\n", b );
    return 0 ;
}
```

Output:

Error. Since there is a semicolon in the macro definition of **AREA**. If we drop the semicolon then the program will compile successfully. Nested macros are allowed.

[C] Attempt the following:

- (a) If a macro is not getting expanded as per your expectation, how will you find out how is it being expanded by the preprocessor.

Answer:

In such a case we should preprocess our program and see the expanded source code. Assuming that your program is stored in a file called PR1.C, For Turbo C++ environment this can be done as shown below:

```
C:\> CPP PR1.C
```

Here CPP stands for C PreProcessor. On running this preprocessor on PR1.C a file PR1.I will get created. This file contains the expanded source code. This file can be opened in Turbo C++ editor (or any other editor) and its contents can be viewed to find out how the macro has been expanded by the preprocessor.

- (b) Write down macro definitions for the following:

1. To test whether a character is a small case letter or not.
2. To test whether a character is an upper case letter or not.
3. To test whether a character is an alphabet or not. Make use of the macros you defined in 1 and 2 above.
4. To obtain the bigger of two numbers.

Program:

```
/* Macros like ISUPPER, ISLOWER, ISAPLHA, BIG */  
#include <stdio.h>  
  
#define ISUPPER(x) ( x >= 65 && x <= 90 ? 1 : 0 )  
#define ISLOWER(x) ( x >= 97 && x <= 122 ? 1 : 0 )  
#define ISALPHA(x) ( ISUPPER(x) || ISLOWER(x) )
```

```
#define BIG(x,y) ( x > y ? x : y )

int main( )
{
    char ch ;
    int d, a, b ;

    printf ( "\nEnter any alphabet/character: " ) ;
    scanf ( "%c", &ch ) ;

    if ( d = ISUPPER ( ch ) == 1 ) /* Macro substitution */
        printf ( "You entered a capital letter\n" ) ;
    else if ( d = ISLOWER ( ch ) == 1 ) /* Macro substitution */
        printf ( "You entered a small case letter\n" ) ;
    else if ( d = ISALPHA ( ch ) != 1 ) /* Macro substitution */
        printf ( "You entered character other than an alphabet\n" ) ;

    printf ( "\n\nEnter any two numbers: " ) ;
    scanf ( "%d%d", &a, &b ) ;

    d = BIG ( a, b ) ; /* Macro substitution */
    printf ( "Bigger number is %d\n", d ) ;

    return 0 ;
}
```

- (c) Write macro definitions with arguments for calculation of area and perimeter of a triangle, a square and a circle. Store these macro definitions in a file called “areaperi.h”. Include this file in your program, and call the macro definitions for calculating area and perimeter for different squares, triangles and circles.

Program:

```
/* areaperi.h */
```

```
/* Storing the macro definitions of area and perimeter of circle, triangle  
and square in the "areaperi.h" header file */
```

```
#define PI 3.1415  
#define PERIC( r ) ( 2 * PI * r )  
#define AREAC( r ) ( PI * r * r )  
#define PERIS( x ) ( 4 * x )  
#define AREAS( x ) ( x * x )  
#define PERIT( x, y, z ) ( x + y + z )  
#define AREAT( b, h ) ( 0.5 * b * h )
```

```
/* Main program to calculate of area, perimeter and circumference using  
macros in header file "areaperi.h" */
```

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

```
/* include file containing macro definitions */
```

```
# include "areaperi.h"
```

```
int main( )
```

```
{
```

```
    int d, a, b ;
```

```
    float sid1, sid2, sid3, sid, p_tri, p_cir, p_sqr, a_tri, a_cir, a_sqr ;
```

```
    float r, base, height ;
```

```
    printf ( "\nEnter radius of circle: " ) ;
```

```
    scanf ( "%f", &r ) ;
```

```
    p_cir = PERIC ( r ) ;
```

```
    printf ( "Circumference of circle = %f\n", p_cir ) ;
```

```
    a_cir = AREAC ( r ) ;
```

```
    printf ( "Area of circle = %f\n", a_cir ) ;
```

```
    printf ( "\n\nEnter side of a square: " ) ;
```

```
    scanf ( "%f", &sid ) ;
```

```
    p_sqr = PERIS ( sid ) ;
```

```
    printf ( "Perimeter of square = %f\n", p_sqr ) ;
```

```
    a_sqr = AREAS ( sid ) ;
```

```
    printf ( "Area of square = %f\n", a_sqr ) ;
```

```

printf ( "\n\nEnter length of 3 sides of triangle: " );
scanf ( "%f %f %f", &sid1, &sid2, &sid3 );
p_tri = PERIT ( sid1, sid2, sid3 );
printf ( "Perimeter of triangle = %f\n", p_tri );

printf ( "\n\nEnter base and height of triangle: " );
scanf ( "%f %f", &base, &height );
a_tri = AREAT ( base, height );
printf ( "Area of triangle = %f\n", a_tri );

return 0 ;
}

```

(d) Write down macro definitions for the following:

1. To find arithmetic mean of two numbers.
2. To find absolute value of a number.
3. To convert an uppercase alphabet to lowercase.
4. To obtain the bigger of two numbers.

Program:

```

/* Macros like MEAN, ABS, TOLOWER, BIG */
#include <stdio.h>

/* Macros Defined Below */
#define MEAN(x,y) ( ( x + y ) / 2 )
#define ABS(x) ( x < 0 ? x * - 1 : x )
#define TOLOWER(x) ( x + 32 )
#define BIG(x,y,z) ( x > y && x > z ? x : y > x && y > z ? y : z )

int main( )
{
    char ch ;
    int d, a, b, c ;

    printf ( "\n\nEnter any two numbers: " );
    scanf ( "%d %d", &a, &b );

```

```
d = MEAN ( a, b ) ; /* Macro substitution */
printf ( "Mean is %d\n", d ) ;

printf ( "\nEnter any number: " ) ;
scanf ( "%d", &a ) ;

d = ABS ( a ) ;
printf ( "Absolute value is %d\n", d ) ;

fflush ( stdin ) ;
printf ( "\nEnter any upper case character: " ) ;
scanf ( "%c", &ch ) ;

ch = TOLOWER ( ch ) ;
printf ( "Lower case character is %c\n", ch ) ;

printf ( "\nEnter any three numbers: " ) ;
scanf ( "%d %d %d", &a, &b, &c ) ;

d = BIG ( a, b, c ) ;
printf ( "Big number is: %d\n", d ) ;

return 0 ;
}
```

- (e) Write macro definitions with arguments for calculation of Simple Interest and Amount. Store these macro definitions in a file called “interest.h”. Include this file in your program, and use the macro definitions for calculating simple interest and amount.

Program:

```
/* interest.h */
/* Storing the macro definitions of Simple Interest and Amount in the
“interest.h” header file */
```

```
#define SI( p, n, r ) ( p * n * r / 100 )
#define AMT( p, SI ) ( p + SI )

/* Main Program to calculate simple interest and amount by including
"interest.h" header file*/
# include <stdio.h>
# include "interest.h"

int main( )
{
    int p, n ;
    float si, amt, r ;

    printf ( "\nEnter Principal, no. of years and rate of interest: " ) ;
    scanf ( "%d %d %f", &p, &n, &r ) ;

    si = SI ( p, n, r ) ;
    amt = AMT ( si, p ) ;

    printf ( "Simple interest is: %f\nAmount is: %f\n", si, amt ) ;

    return 0 ;
}
```


CHAPTER THIRTEEN

Arrays

[A] What will be the output of the following programs:

(a)

```
#include <stdio.h>
int main( )
{
    int num[ 26 ], temp ;
    num[ 0 ] = 100 ;
    num[ 25 ] = 200 ;
    temp = num[ 25 ] ;
    num[ 25 ] = num[ 0 ] ;
    num[ 0 ] = temp ;
    printf ( "%d %d\n", num[ 0 ], num[ 25 ] ) ;
    return 0 ;
}
```

Output:

200 100

(b)

```
#include <stdio.h>
int main( )
{
    int array[ 26 ], i ;
    for ( i = 0 ; i <= 25 ; i++ )
    {
        array[ i ] = 'A' + i ;
    }
}
```

```

        printf ( "%d %c\n", array[ i ], array[ i ] );
    }
    return 0 ;
}

```

Output:

```

65  A
66  B
.....
.....
90  Z

```

```

(c) #include <stdio.h>
int main( )
{
    int sub[ 50 ], i ;
    for ( i = 0 ; i <= 48 ; i++ ) ;
    {
        sub[ i ] = i ;
        printf ( "%d\n", sub[ i ] );
    }
    return 0 ;
}

```

Output:

49. Since I takes a value 49 when it reaches the statement **sub[i] = i ;**

[B] Point out the errors, if any, in the following program segments:

```

(a) /* mixed has some char and some int values */
#include <stdio.h>
int char mixed[ 100 ] ;
int main( )
{
    int a[ 10 ], i ;

```

```
    for ( i = 1 ; i <= 10 ; i++ )
    {
        scanf ( "%d", a[ i ] );
        printf ( "%d\n", a[ i ] );
    }
    return 0 ;
}
```

Error. An array cannot be declared to be of the type in char

Logical error. Array bounds are exceeded

```
(b) #include <stdio.h>
int main( )
{
    int size ;
    scanf ( "%d", &size ) ;
    int arr[ size ] ;
    for ( i = 1 ; i <= size ; i++ )
    {
        scanf ( "%d", &arr[ i ] );
        printf ( "%d\n", arr[ i ] );
    }
    return 0 ;
}
```

Error. Dimension of the array should be constant and all declarations should be at the beginning.

```
(c) #include <stdio.h>
int main( )
{
    int i, a = 2, b = 3 ;
    int arr[ 2 + 3 ] ;
    for ( i = 0 ; i < a + b ; i++ )
    {
        scanf ( "%d", &arr[ i ] );
        printf ( "%d\n", arr[ i ] );
    }
}
```

```
    return 0 ;  
}
```

No Error.

[C] Answer the following:

(a) An array is a collection of

1. different data types scattered throughout memory
2. the same data type scattered throughout memory
3. the same data type placed next to each other in memory
4. different data types placed next to each other in memory

Answer:

3. the same data type placed next to each other in memory

(b) Are the following array declarations correct?

```
int a (25) ;  
int size = 10, b[ size ] ;  
int c = { 0, 1, 2 } ;
```

Answer:

No. All the declarations are wrong.

(c) Which element of the array does this expression reference?

```
num[ 4 ]
```

Answer:

Fifth element.

(d) What is the difference between the 5's in these two expressions? (Select the correct answer)

```
int num[ 5 ];  
num[ 5 ] = 11 ;
```

1. first is particular element, second is type
2. first is array size, second is particular element
3. first is particular element, second is array size
4. both specify array size

Answer:

2. first is array size, second is particular element

(e) State whether the following statements are True or False:

1. The array **int num[26]** has twenty-six elements.

Answer: True

2. The expression **num[1]** designates the first element in the array

Answer: False

3. It is necessary to initialize the array at the time of declaration.

Answer: False

4. The expression **num[27]** designates the twenty-eighth element in the array.

Answer: True

[D] Attempt the following:

- (a) Twenty-five numbers are entered from the keyboard into an array. The number to be searched is entered through the keyboard by the user. Write a program to find if the number to be searched is present in the array and if it is present, display the number of times it appears in the array.

Program

```
/* Program to find a number and its frequency in array */
#include <stdio.h>

int main( )
{
    int num[ 25 ], i, count = 0, n ;

    printf ( "\nEnter 25 elements of array:\n" ) ;
    for ( i = 0 ; i <= 24 ; i++ )
        scanf ( "%d", &num[ i ] ) ; /* Array Elements */

    printf ( "\nEnter an element to search: " ) ;
    scanf ( "%d", &n ) ;

    for ( i = 0 ; i <= 24 ; i++ )
    {
        if ( num[ i ] == n )
            count++ ;
    }

    printf ( "Number %d is found %d time(s) in the array\n", n, count ) ;

    return 0 ;
}
```

(b) Implement the Selection Sort, Bubble Sort and Insertion sort algorithms on a set of 25 numbers. (Refer Figure 13.4 for the logic of the algorithms)

- Selection sort
- Bubble Sort
- Insertion Sort

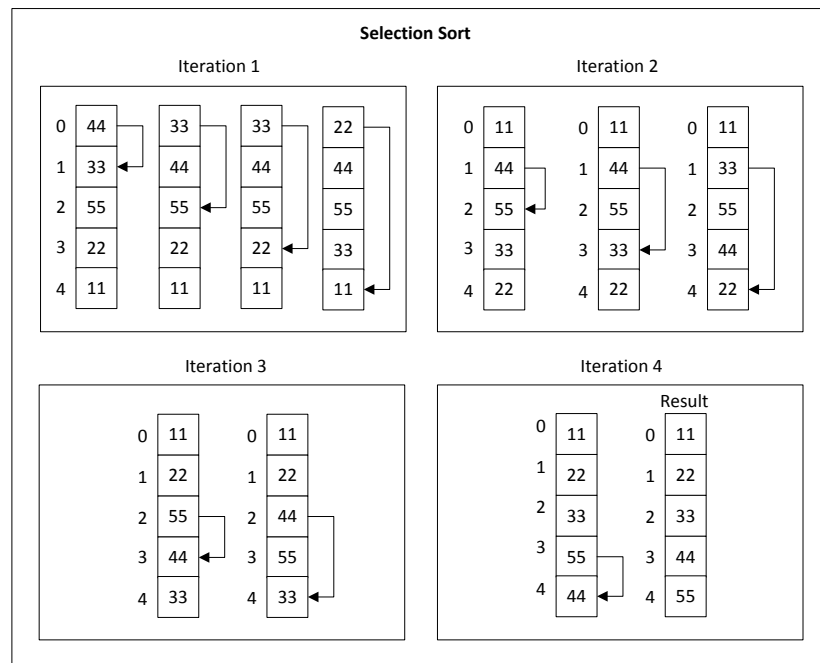


Figure 13.4 (a)

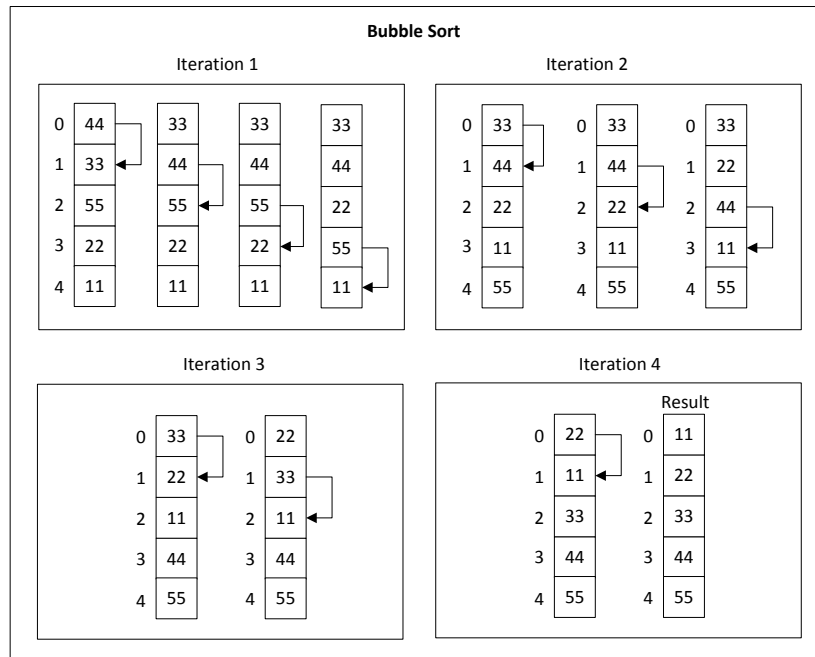


Figure 13.4 (b)

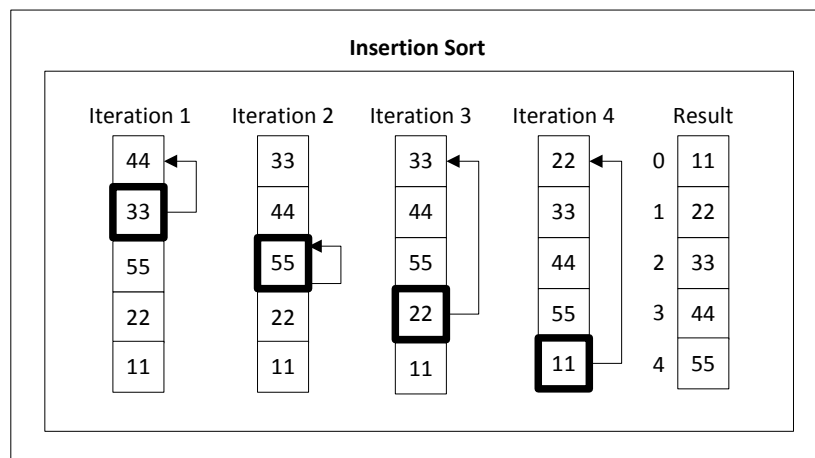


Figure 13.4 (c)

Program

```
/* Selection Sort */
# include <stdio.h>

int main( )
{
    int a[ 25 ], i, j, t ;

    printf ( "\nEnter 25 numbers: " ) ;

    for ( i = 0 ; i <= 24 ; i++ )
        scanf ( "%d", &a[ i ] ) ;

    for ( i = 0 ; i <= 23 ; i++ ) /* number of passes */
    {
        for ( j = i + 1 ; j <= 24 ; j++ ) /* start at next element */
        {
            /* compare a[ i ] with all elements a[ j ] one by one */
            if ( a[ i ] > a[ j ] )
            {
                t = a[ i ] ; /* Interchange if greater than next element */
                a[ i ] = a[ j ] ;
                a[ j ] = t ;
            }
        }
    }

    printf ( "\nSorted Numbers are:\n" ) ;
    for ( i = 0 ; i <= 24 ; i++ )
        printf ( "%d\n", a[ i ] ) ; /* print the sorted array */

    return 0 ;
}

/* Exchange Sort */
# include <stdio.h>
```

```
int main( )
{
    int a[ 25 ], i, j, m, t ;

    printf ( "\nEnter 25 numbers:" );
    for ( i = 0 ; i <= 24 ; i++ )
        scanf ( "%d", &a[ i ] );

    for ( i = 0 ; i <= 24 ; i++ ) /* number of passes */
    {
        for ( j = 0 ; j < 24 - i ; j++ ) /*start another loop from beginning*/
        {
            /* compare an element with the next element one by one */
            if ( a[ j ] > a[ j + 1 ] )
            {
                t = a[ j ] ; /* interchange the two if first is greater */
                a[ j ] = a[ j + 1 ] ;
                a[ j + 1 ] = t ;
            }
        }
    }

    printf ( "\nSorted Numbers are:\n" );
    for ( i = 0 ; i <= 24 ; i++ )
        printf ( "%d\n", a[ i ] );

    return 0 ;
}

/* Insertion Sort */
# include <stdio.h>

int main( )
{
    int a[ 25 ], i, j, k, t ;

    printf ( "\nEnter 25 Numbers:\n" );
    for ( i = 0 ; i <= 24 ; i++ )
```

```

scanf ( "%d", &a[ i ] );

for ( i = 1 ; i <= 24 ; i++ ) /* number of passes */
{
    t = a[ i ] ;
    for ( j = 0 ; j < i ; j++ )
    {
        if ( t < a[ j ] )
        {
            for ( k = i ; k >= j ; k-- )
                a[ k ] = a[ k - 1 ] ; /* shift elements to left */
            a[ j ] = t ;
            break ;
        }
    }
}

printf ( "\nSorted Numbers are:\n" ) ;
for ( i = 0 ; i <= 24 ; i++ )
    printf ( "%d\n", a[ i ] ) ;

return 0 ;
}

```

- (c) Implement the following procedure to generate prime numbers from 1 to 100 in a program. This procedure is called sieve of Eratosthenes.

- step 1 Fill an array **num[100]** with numbers from 1 to 100
- step 2 Starting with the second entry in the array, set all its multiples to zero.
- step 3 Proceed to the next non-zero element and set all its multiples to zero.
- step 4 Repeat step 3 till you have set up the multiples of all the non-zero elements to zero

step 5 At the conclusion of step 4, all the non-zero entries left in the array would be prime numbers, so print out these numbers.

Program:

```
/* Sieve of Eratosthenes */
#include <stdio.h>

int main( )
{
    int num[ 100 ], i, j, k, step ;

    for ( i = 0 ; i <= 99 ; i++ )
        num[ i ] = i + 1 ; /* fill array with numbers from 1 to 100 */

    for ( i = 1 ; i <= 99 ; i++ )
    {
        if ( num[ i ] != 0 )
        {
            k = num[ i ] * 2 - 1 ;
            step = num[ i ] ;
            for ( j = k ; j <= 99 ; j = j + step )
                num[ j ] = 0 ;
        }
    }

    printf ( "\nPrime numbers between 1 & 100 are:\n" ) ;
    for ( i = 0 ; i <= 99 ; i++ )
    {
        if ( num[ i ] != 0 )
            printf ( "%d\n", num[ i ] ) ;
    }

    return 0 ;
}
```

- (d) Twenty-five numbers are entered from the keyboard into an array. Write a program to find out how many of them are positive, how many are negative, how many are even and how many odd.

Program

```
/* Program to count positive, negative, odd & even nos in an array */
#include <stdio.h>

int main( )
{
    int num[ 25 ], i, neg = 0, pos = 0, odd = 0, even = 0 ;

    printf ( "Enter 25 elements of array" ) ;
    for ( i = 0 ; i <= 24 ; i++ )
        scanf ( "%d", &num[ i ] ) ; /* Array Elements */

    for ( i = 0 ; i <= 24 ; i++ )
    {
        num[ i ] < 0 ? neg++ : ( pos++ ) ; /* conditional operators */
        num[ i ] % 2 ? odd++ : ( even++ ) ;
    }

    printf ( "Negative elements = %d\n", neg ) ;
    printf ( "Positive elements = %d\n", pos ) ;
    printf ( "Even elements = %d\n", even ) ;
    printf ( "Odd elements = %d\n", odd ) ;

    return 0 ;
}
```

- (e) Write a program that interchanges the odd and even elements of an array.

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

```
int main( )
{
    int num[ ] = { 12, 4, 5, 1, 9, 13, 11, 19, 54, 34 };
    int i, t;

    for ( i = 0 ; i <= 9 ; i = i + 2 )
    {
        t = num[ i ];
        num [ i ] = num [ i + 1 ];
        num [ i + 1 ] = t;
    }

    for ( i = 0 ; i <= 9 ; i++ )
        printf ( "%d\n", num[ i ] );

    return 0 ;
}
```

[E] What will be the output of the following programs:

(a) `# include <stdio.h>`
`int main()`
`{`
 `int b[] = { 10, 20, 30, 40, 50 };`
 `int i;`
 `for (i = 0 ; i <= 4 ; i++)`
 `printf ("%d\n", *(b + i));`
 `return 0 ;`
`}`

Output:

10
20
30
40
50

```
(b) #include <stdio.h>
int main( )
{
    int b[] = { 0, 20, 0, 40, 5 };
    int i, *k;
    k = b;
    for ( i = 0 ; i <= 4 ; i++ )
    {
        printf ( "%d\n", *k );
        k++;
    }
    return 0 ;
}
```

Output:

```
0
20
0
40
5
```

```
(c) #include <stdio.h>
void change ( int *, int );
int main( )
{
    int a[] = { 2, 4, 6, 8, 10 };
    int i;
    change ( a, 5 );
    for ( i = 0 ; i <= 4 ; i++ )
        printf ( "%d\n", a[ i ] );
    return 0 ;
}
void change ( int *b, int n )
{
    int i;
    for ( i = 0 ; i < n ; i++ )
```



```
        *( b + i ) = *( b + i ) + 5 ;  
    }
```

Output:

```
7  
9  
11  
13  
15
```

(d)

```
# include <stdio.h>  
int main( )  
{  
    static int  a[ 5 ] ;  
    int  i ;  
    for ( i = 0 ; i <= 4 ; i++ )  
        printf ( "%d\n", a[ i ] ) ;  
    return 0 ;  
}
```

Output:

```
0  
0  
0  
0  
0
```

(e)

```
# include <stdio.h>  
int main( )  
{  
    int  a[ 5 ] = { 5, 1, 15, 20, 25 } ;  
    int  i, j, k = 1, m ;  
    i = ++a[ 1 ] ;  
    j = a[ 1 ]++ ;  
    m = a[ i++ ] ;  
    printf ( "%d %d %d\n", i, j, m ) ;  
}
```

Output:

3 2 15

[F] Point out the errors, if any, in the following programs:

(a)

```
#include <stdio.h>
int main( )
{
    int array[ 6 ] = { 1, 2, 3, 4, 5, 6 };
    int i ;
    for ( i = 0 ; i <= 25 ; i++ )
        printf ( "%d\n", array[ i ] );
    return 0 ;
}
```

No Error. Caution: Array bounds are being exceeded.

(b)

```
#include <stdio.h>
int main( )
{
    int sub[ 50 ], i ;
    for ( i = 1 ; i <= 50 ; i++ )
    {
        sub[ i ] = i ;
        printf ( "%d\n", sub[ i ] );
    }
    return 0 ;
}
```

No Error. Caution: Array bounds are being exceeded.

(c)

```
#include <stdio.h>
int main( )
{
    int a[ ] = { 10, 20, 30, 40, 50 };
    int j ;
    j = a ; /* store the address of zeroth element */
}
```

```
j = j + 3 ;  
printf ( "%d\n", *j ) ;  
return 0 ;  
}
```

Error. It should be **int *j**.

```
(d) #include <stdio.h>  
int main( )  
{  
    float a[] = { 13.24, 1.5, 1.5, 5.4, 3.5 } ;  
    float *j ;  
    j = a ;  
    j = j + 4 ;  
    printf ( "%d %d %d\n", j, *j, a[ 4 ] ) ;  
    return 0 ;  
}
```

No Error. Use **%f** for printing out ***j** and **a[4]**.

```
(e) #include <stdio.h>  
int main( )  
{  
    int max = 5 ;  
    float arr[ max ] ;  
    for ( i = 0 ; i < max ; i++ )  
        scanf ( "%f", &arr[ i ] ) ;  
    return 0 ;  
}
```

Error. Array dimension cannot be variable.

[G] Answer the following:

- (a) What will happen if you try to put so many values into an array when you initialize it that the size of the array is exceeded?
1. nothing

2. possible system malfunction
3. error message from the compiler
4. other data may be overwritten

Answer:

2. possible system malfunction
- (b) In an array `int arr[12]` the word `arr` represents the address of the array.
- (c) What will happen if you put too few elements in an array when you initialize it?
1. nothing
 2. possible system malfunction
 3. error message from the compiler
 4. unused elements will be filled with 0's or garbage

Answer:

4. unused elements will be filled with 0's or garbage
- (d) What will happen if you assign a value to an element of an array whose subscript exceeds the size of the array?
1. the element will be set to 0
 2. nothing, it's done all the time
 3. other data may be overwritten
 4. error message from the compiler

Answer:

3. other data may be overwritten
- (e) When you pass an array as an argument to a function, what actually gets passed?
1. address of the array
 2. values of the elements of the array

3. address of the first element of the array
4. number of elements of the array

Answer:

1. address of the array

(f) Which of these are reasons for using pointers?

1. To manipulate parts of an array
2. To refer to keywords such as **for** and **if**
3. To return more than one value from a function
4. To refer to particular programs more conveniently

Answer:

1. To manipulate parts of array
3. To return more than one value from a function

(g) If you don't initialize a static array, what will be the elements set to?

1. 0
2. an undetermined value
3. a floating point number
4. the character constant '\0'

Answer:

1. 0

[H] State True or False:

(a) Address of a floating-point variable is always a whole number.

Answer: True

- (b) Which of the following is the correct way of declaring a **float** pointer:

1. float ptr ;
2. float *ptr ;
3. *float ptr ;
4. None of the above

Answer:

2. float *ptr

- (c) Add the missing statement for the following program to print 35.

```
#include <stdio.h>
int main( )
{
    int j, *ptr ;
    *ptr = 35 ;
    printf ( "%d\n", j ) ;
    return 0 ;
}
```

Answer:

ptr = &j ;

- (d) if **int s[5]** is a one-dimensional array of integers, which of the following refers to the third element in the array?

1. *(s + 2)
2. *(s + 3)
3. s + 3
4. s + 2

Answer:

1. * (s + 2)

[I] Attempt the following:

- (a) Write a program to copy the contents of one array into another in the reverse order.

Program:

```
/* Program to copy one array into another in reverse order */
#include <stdio.h>

int main( )
{
    int arr1[ 5 ], arr2[ 5 ], i, j ;

    printf ( "\nEnter 5 elements of array:\n" );
    for ( i = 0 ; i <= 4 ; i++ )
        scanf ( "%d", &arr1[ i ] );

    for ( i = 0, j = 4 ; i <= 4 ; i++, j-- )
        arr2[ j ] = arr1[ i ];

    printf ( "\nElements in reverse order:\n" );
    for ( i = 0 ; i <= 4 ; i++ )
        printf ( "%d\n", arr2[ i ] );

    return 0 ;
}
```

- (b) If an array **arr** contains **n** elements, then write a program to check if **arr[0] = arr[n-1]**, **arr[1] = arr[n-2]** and so on.

Program:

```
/* Program to check if arr[ 0 ]=arr[ n - 1 ] and so on */
#include <stdio.h>

int main( )
```

```
{
    int arr[ 10 ], i, j ;

    printf ( "\nEnter 10 elements of array:\n" );
    for ( i = 0 ; i <= 9 ; i++ )
        scanf ( "%d", &arr[ i ] );

    for ( i = 0 ; i <= 9 ; i++ )
    {
        if ( arr[ i ] == arr[ 10 - ( i + 1 ) ] )
            printf ( "%d\n", arr[ i ] );
    }

    return 0 ;
}
```

- (c) Write a program using pointers to find the smallest number in an array of 25 integers.

Program:

```
/* Program to find smallest element using pointer */
# include <stdio.h>

int main( )
{
    int arr[ 25 ], i, n ;

    printf ( "\nEnter 25 elements of array:\n" );
    for ( i = 0 ; i <= 24 ; i++ )
        scanf ( "%d", &arr[ i ] );

    n = *arr ;

    for ( i = 0 ; i <= 24 ; i++ )
    {
        if ( * ( arr + i ) < n )
            n = * ( arr + i );
    }
}
```



```
    }

    printf ( "Smallest number in array is %d\n", n ) ;

    return 0 ;
}
```

(d) Write a program which performs the following tasks:

- initialize an integer array of 10 elements in **main()**
- pass the entire array to a function **modify()**
- in **modify()** multiply each element of array by 3
- return the control to **main()** and print the new array elements in **main()**

Program:

```
/* Program to pass the entire array and multiply each element by 3 */
#include <stdio.h>

int main( )
{
    int i ;
    static int array[ ] = { 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 } ;

    printf ( "\nOriginal Array is:\n" ) ;
    for ( i = 0 ; i < 10 ; i++ )
        printf ( "%d ", array[ i ] ) ;

    modify ( array, 10 ) ;

    printf ( "\n\nModified Array is: \n" ) ;
    for ( i = 0 ; i < 10 ; i++ )
        printf ( "%d ", array[ i ] ) ;

    return 0 ;
}
```

```
/* Function to modify array */
modify ( int *arr, int n )
{
    int i ;
    for ( i = 0 ; i < n ; i++ )
    {
        *arr = *arr * 3 ;
        arr++ ;
    }
}
```


CHAPTER

FOURTEEN

Multidimensional Arrays

[A] What will be the output of the following programs:

(a)

```
#include <stdio.h>
int main( )
{
    int n[ 3 ][ 3 ] = {
        2, 4, 3,
        6, 8, 5,
        3, 5, 1
    };
    printf ( "%d %d %d\n", *n, n[ 3 ][ 3 ], n[ 2 ][ 2 ] );
    return 0 ;
}
```

Output:

<base address><garbage value> 1

(b)

```
#include <stdio.h>
int main( )
{
    int n[ 3 ][ 3 ] = {
        2, 4, 3,
```

```

        6, 8, 5,
        3, 5, 1
    };

    int i, *ptr;
    ptr = n;
    for ( i = 0 ; i <= 8 ; i++ )
        printf ( "%d\n", *( ptr + i ) );
    return 0 ;
}

```

Output:

```

2
4
3
6
8
5
3
5
1

```

```

(c) #include <stdio.h>
int main( )
{
    int n[ 3 ][ 3 ] = {
        2, 4, 3,
        6, 8, 5,
        3, 5, 1
    };

    int i, j;
    for ( i = 0 ; i <= 2 ; i++ )
        for ( j = 0 ; j <= 2 ; j++ )
            printf ( "%d %d\n", n[ i ][ j ], *( n + i ) + j );
    return 0 ;
}

```

Output:

```
2 2
4 4
3 3
6 6
....
....
1 1
```

[B] Point out the errors, if any, in the following programs:

```
(a) #include <stdio.h>
int main( )
{
    int twod[ ][ ] = {
                                2, 4,
                                6, 8
                            };
    printf ( "%d\n", twod );
    return 0 ;
}
```

Error. While declaring a two dimensional array mentioning the column dimension is necessary

```
(b) #include <stdio.h>
int main( )
{
    int three[ 3 ][ ] = {
                                2, 4, 3,
                                6, 8, 2,
                                2, 3 ,1
                            };
    printf ( "%d\n", three[ 1 ][ 1 ] );
    return 0 ;
}
```

Error. While declaring a two dimensional array mentioning the column dimension is necessary

[C] Attempt the following:

- (a) How will you initialize a three-dimensional array **threed[3][2][3]**? How will you refer the first and last element in this array?

Answer:

```
int arr[ 3 ][ 2 ][ 3 ] = {
    {
        { 1, 2, 3 },
        { 4, 5, 6 }
    },
    {
        { 1, 2, 3 },
        { 4, 5, 6 }
    },
    {
        { 1, 2, 3 },
        { 4, 5, 6 }
    }
};
```

The first element of the array is **arr[0][0][0]** or *****arr**.
The last element of the array is **arr[2][1][2]** or ***(*(*(arr + 2) + 1) + 2)**.

- (b) Write a program to pick up the largest number from any 5 row by 5 column matrix.

Program:

```
/* Pick up largest number from 5 x 5 matrix */
#include <stdio.h>

int main( )
{
```

```
int a[ 5 ][ 5 ] = {
    { 11, 1, 7, 9, 7 },
    { 13, 54, 56, 2, 5 },
    { 23, 43, 89, 22, 13 },
    { 14, 15, 17, 16, 19 },
    { 45, 3, 6, 8, 10 }
};

int i, j, big ;

big = a[ 0 ][ 0 ];
printf ( "\nThe 5 x 5 matrix is:\n" );

for ( i = 0 ; i <= 4 ; i++ )
{
    for ( j = 0 ; j <= 4 ; j++ )
    {
        printf ( "%d\t", a[ i ][ j ] );
        if ( a[ i ][ j ] > big )
            big = a[ i ][ j ];
    }
    printf ( "\n" );
}

printf ( "\nLargest number in the matrix is %d\n", big );

return 0 ;
}
```

- (c) Write a program to obtain transpose of a 4 x 4 matrix. The transpose of a matrix is obtained by exchanging the elements of each row with the elements of the corresponding column.

Program:

```
/* Transpose of a 4 x 4 matrix */
# include <stdio.h>
```



```
int main( )
{
    int mat[ 4 ][ 4 ], i, j, temp ;

    printf ( "\nEnter values for 4 x 4 matrix:\n " );

    for ( i = 0 ; i <= 3 ; i++ )
    {
        for ( j = 0 ; j <= 3 ; j++ )
            scanf ( "%d", &mat[ i ][ j ] );
    }

    printf ( "\n\nThe matrix you entered is:\n" );

    for ( i = 0 ; i <= 3 ; i++ )
    {
        for ( j = 0 ; j <= 3 ; j++ )
            printf ( "%d\t", mat[ i ][ j ] );

        printf ( "\n" );
    }

    /* Transpose the matrix */
    for ( i = 0 ; i <= 3 ; i++ )
    {
        for ( j = i + 1 ; j <= 3 ; j++ )
        {
            temp = mat[ i ][ j ] ;
            mat[ i ][ j ] = mat[ j ][ i ] ;
            mat[ j ][ i ] = temp ;
        }
    }

    printf ( "\n\nTranspose of the matrix is:\n" );
    for ( i = 0 ; i <= 3 ; i++ )
    {
        for ( j = 0 ; j <= 3 ; j++ )
```

```

        printf ( "%d\t", mat[ i ][ j ] );
    printf ( "\n" );
}

return 0 ;
}

```

- (d) Very often in fairs we come across a puzzle that contains 15 numbered square pieces mounted on a frame. These pieces can be moved horizontally or vertically. A possible arrangement of these pieces is shown below:

1	4	15	7
8	10	2	11
14	3	6	13
12	9	5	

Figure 14.8

As you can see there is a blank at bottom right corner. Implement the following procedure through a program:

Draw the boxes as shown above. Display the numbers in the above order. Allow the user to hit any of the arrow keys (up, down, left, or right). If you are using Turbo C/C++, use the library function **gotoxy()** to position the cursor on the screen while drawing the boxes. If you are using Visual Studio then use the following function to position the cursor.

```

#include <windows.h>
void gotoxy ( short col, short row )

```

```

{
    HANDLE h = GetStdHandle ( STD_OUTPUT_HANDLE );
    COORD position = { col, row };
    SetConsoleCursorPosition ( h, position );
}

```

If user hits say, right arrow key then the piece with a number 5 should move to the right and blank should replace the original position of 5. Similarly, if down arrow key is hit, then 13 should move down and blank should replace the original position of 13. If left arrow key or up arrow key is hit then no action should be taken.

The user would continue hitting the arrow keys till the numbers aren't arranged in ascending order.

Keep track of the number of moves in which the user manages to arrange the numbers in ascending order. The user who manages it in minimum number of moves is the one who wins.

How do we tackle the arrow keys? We cannot receive them using **scanf()** function. Arrow keys are special keys which are identified by their 'scan codes'. Use the following function in your program. It would return the scan code of the arrow key being hit. The scan codes for the arrow keys are:

up arrow key – 72 down arrow key – 80
 left arrow key – 75 right arrow key – 77

```

#include <conio.h>
int getkey( )
{
    int ch ;
    ch = getch( ) ;
    if ( ch == 0 )

```

```
    {  
        ch = getch( ) ;  
        return ch ;  
    }  
    return ch ;  
}
```

Program:

```
/* Video game : Shuffle */  
# include <stdio.h>  
# include <conio.h>  
# include <windows.h>  
  
void boxes( ) ;  
void display( ) ;  
int getkey( ) ;  
void check( ) ;  
  
/* If you are using Turbo C++ delete the following line */  
void gotoxy ( short int col, short int row ) ;  
  
int arr[ 4 ][ 4 ] = {  
    { 1, 4, 15, 7 } ,  
    { 8, 10, 2, 11 } ,  
    { 4, 3, 6, 13 } ,  
    { 2, 9, 5, 0 }  
};  
  
int main( )  
{  
    int row = 3, col = 3, t, ch ;  
  
    boxes( ) ; /* function to draw boxes */  
    display( ) ; /* function to display numbers */  
  
    while ( 1 )  
    {  
        ch = getkey( ) ; /* returns scan code of key that has been hit */
```

```
switch ( ch )
{
    case 80 : /* Down Arrow */
        if ( row == 0 )
        {
            printf ( "\a" );
            break ;
        }
        t = arr[ row ][ col ] ;
        arr[ row ][ col ] = arr[ row - 1 ][ col ] ;
        arr[ row - 1 ][ col ] = t ;
        row-- ;
        display( ) ;
        break ;

    case 77 : /* Right Arrow */
        if ( col == 0 )
        {
            printf ( "\a" );
            break ;
        }
        t = arr[ row ][ col ] ;
        arr[ row ][ col ] = arr[ row ][ col - 1 ] ;
        arr[ row ][ col - 1 ] = t ;
        col-- ;
        display( ) ;
        break ;

    case 72 : /* Up Arrow */
        if ( row == 3 )
        {
            printf ( "\a" );
            break ;
        }
        t = arr[ row ][ col ] ;
        arr[ row ][ col ] = arr[ row + 1 ][ col ] ;
        arr[ row + 1 ][ col ] = t ;
        row++ ;
}
```

```
        display( );
        break ;

    case 75 : /* Left Arrow */
        if ( col == 3 )
        {
            printf ( "\a" );
            break ;
        }
        t = arr[ row ][ col ];
        arr[ row ][ col ] = arr[ row ][ col + 1 ];
        arr[ row ][ col + 1 ] = t ;
        col++ ;
        display( );
        break ;

    case 27 : /* Esc key */
        exit ( 0 );
    }
    check( );
}
return 0 ;
}

void check( )
{
    static int move = 0 ;
    int k = 1, i, j ;

    move++ ;
    gotoxy ( 30, 24 ) ;

    printf ( "no of moves = %d", move ) ;
    for ( i = 0 ; i <= 3 ; i++ )
    {
        for ( j = 0 ; j <= 3 ; j++ )
        {
            if ( arr[ i ][ j ] == 0 )
```

```
        continue ;
    else
        if ( arr[ i ][ j ] == k )
            k++ ;
        else
            return ;
    }
}
exit ( 0 ) ;
}

void boxes ( ) /* draws boxes using graphics characters */
{
    int r , c ; /* row & column */

    for ( c = 30 ; c <= 42 ; c++ )
    {
        for ( r = 8 ; r <= 16 ; r+=2 )
        {
            gotoxy ( c, r ) ;
            printf ( "%c", 196 ) ;
        }
    }

    for ( r = 8 ; r <= 16 ; r++ )
    {
        for ( c = 30 ; c <= 42 ; c += 3 )
        {
            gotoxy ( c, r ) ;
            printf ( "%c", 179 ) ;
        }
    }

    for ( c = 33 ; c <= 39 ; c += 3 )
    {
        gotoxy ( c, 8 ) ;
        printf ( "%c", 194 ) ;
    }
}
```

```
        gotoxy ( c, 16 );
        printf ( "%c", 193 );
    }

    for ( r = 10 ; r <= 14 ; r+=2 )
    {
        gotoxy ( 30, r );
        printf ( "%c", 195 );

        gotoxy ( 42, r );
        printf ( "%c", 180 );
    }

    for ( r = 10 ; r <= 14 ; r+=2 )
    {
        for ( c = 33 ; c <= 39 ; c += 3 )
        {
            gotoxy ( c, r );
            printf ( "%c", 197 );
        }
    }

    gotoxy ( 30, 8 );
    printf ( "%c", 218 );

    gotoxy ( 42, 8 );
    printf ( "%c", 191 );

    gotoxy ( 30, 16 );
    printf ( "%c", 192 );

    gotoxy ( 42, 16 );
    printf ( "%c", 217 );
}

void display( ) /* display numbers in the boxes */
{
    int r = 9, c = 31, i, j ;
```



```
for ( i = 0 ; i <= 3 ; i++ )
{
    for ( j = 0 ; j <= 3 ; j++ )
    {
        if ( arr[ i ][ j ] == 0 )
        {
            gotoxy ( c, r ) ;
            printf ( " " ) ;
        }
        else
        {
            gotoxy ( c, r ) ;
            printf ( "%d", arr[ i ][ j ] ) ;
        }
        c = c + 3 ;
    }
    r = r + 2 ;
    c = 31 ;
}

/* returns scan code of the key that has been hit, 27 if escape */
int getkey( )
{
    int ch ;
    ch = getch( ) ;
    if ( ch == 0 )
    {
        ch = getch( ) ;
        return ch ;
    }
    return ch ;
}

void gotoxy ( short int col, short int row )
{
    HANDLE hStdout = GetStdHandle ( STD_OUTPUT_HANDLE ) ;
```

```
COORD position = { col, row } ;
SetConsoleCursorPosition ( hStdout, position ) ;
}
```

- (e) Match the following with reference to the following program segment:

```
int i, j, = 25 ;
int *pi, *pj = &j ;
..... /* more lines of program */
.....
*pj = j + 5 ;
j = *pj + 5 ;
pj = pj ;
*pi = i + j ;
```

Each integer quantity occupies 2 bytes of memory. The value assigned to **i** begins at (hexadecimal) address F9C and the value assigned to **j** begins at address F9E. Match the value represented by left hand side quantities with the right.

- | | |
|--------------------|-------------------|
| 1. &i | a. 30 |
| 2. &j | b. F9E |
| 3. pj | c. 35 |
| 4. *pj | d. FA2 |
| 5. i | e. F9C |
| 6. pi | f. 67 |
| 7. *pi | g. unspecified |
| 8. (pi + 2) | h. 65 |
| 9. (*pi + 2) | i. F9E |
| 10. * (pi + 2) | j. F9E |
| | k. FA0 |
| | l. F9D |

Answer

- | | |
|----------|-----------|
| 1. &i | e. F9C |
| 2. &j | b. F9E |

- | | | | |
|-----|--------------|----|-------------|
| 3. | pi | i. | F9E |
| 4. | *pi | h. | 65 |
| 5. | i | c. | 35 |
| 6. | pi | j. | F9E |
| 7. | *pi | h. | 65 |
| 8. | (pi + 2) | d. | FA2 |
| 9. | (*pi + 2) | f. | 67 |
| 10. | * (pi + 2) | g. | unspecified |

(f) Match the following with reference to the following program segment:

```
int x[3][5]= {
                { 1, 2, 3, 4, 5},
                { 6, 7, 8, 9, 10},
                { 11, 12, 13, 14, 15}
            }, *n = &x;
```

- | | | | |
|-----|----------------------|----|----|
| 1. | *(*(x + 2) + 1) | a. | 9 |
| 2. | *(*x + 2) + 5 | b. | 13 |
| 3. | *(*(x + 1)) | c. | 4 |
| 4. | *(*(x) + 2) + 1 | d. | 3 |
| 5. | * (*(x + 1) + 3) | e. | 2 |
| 6. | *n | f. | 12 |
| 7. | *(n + 2) | g. | 14 |
| 8. | *(n + 3) + 1 | h. | 7 |
| 9. | *(n + 5)+1 | i. | 1 |
| 10. | ++*n | j. | 8 |
| | | k. | 5 |
| | | l. | 10 |
| | | m. | 6 |

Answer:

- | | | | |
|----|----------------------|----|----|
| 1. | *(*(x + 2) + 1) | f. | 12 |
| 2. | *(*x + 2) + 5 | j. | 8 |
| 3. | *(*(x + 1)) | m. | 6 |
| 4. | *(*(x) + 2) + 1 | c. | 4 |
| 5. | * (*(x + 1) + 3) | a. | 9 |

- | | |
|----------------------|---------|
| 6. *n | i. 1 |
| 7. *(n +2) | d. 3 |
| 8. (*(n + 3) + 1 | k. 5 |
| 9. *(n + 5)+1 | h. 7 |
| 10. ++*n | e. 2 |

(g) Match the following with reference to the following program segment:

```
unsigned int arr[ 3 ][ 3 ] = {
                                2, 4, 6,
                                9, 1, 10,
                                16, 64, 5
                                };
```

- | | |
|--|----------|
| 1. **arr | a. 64 |
| 2. **arr < *(*arr + 2) | b. 18 |
| 3. *(arr + 2) / (*(*arr + 1) > **arr) | c. 6 |
| 4. *(arr[1] + 1) arr[1][2] | d. 3 |
| 5. *(arr[0]) *(arr[2]) | e. 0 |
| 6. arr[1][1] < arr[0][1] | f. 16 |
| 7. arr[2][[1] & arr[2][0] | g. 1 |
| 8. arr[2][2] arr[0][1] | h. 11 |
| 9. arr[0][1] ^ arr[0][2] | i. 20 |
| 10. ++**arr + --arr[1][1] | j. 2 |
| | k. 5 |
| | l. 4 |

Answer:

- | | |
|---|----------|
| 1. **arr | j. 2 |
| 2. **arr < *(*arr + 2) | g. 1 |
| 3. *(arr + 2) / (*(*arr + 1) > **arr) | c. 6 |
| 4. *(arr[1] + 1) arr[1][2] | h. 11 |
| 5. *(arr[0]) *(arr[2]) | b. 18 |
| 6. arr[1][1] < arr[0][1] | g. 1 |
| 7. arr[2][[1] & arr[2][0] | e. 0 |
| 8. arr[2][2] arr[0][1] | k. 5 |

- | | |
|---|------|
| 9. <code>arr[0][1] ^ arr[0][2]</code> | j. 2 |
| 10. <code>++**arr + --arr[1][1]</code> | d. 3 |

(h) Write a program to find if a square matrix is symmetric.

Program:

```

/* To check if a square matrix is symmetric */
#include <stdio.h>

int main( )
{
    int arr[ 3 ][ 3 ], i, j, count = 0 ;

    printf ( "\nEnter the elements of the Matrix:\n" );
    for ( i = 0 ; i <= 2 ; i++ )
    {
        for ( j = 0 ; j <= 2 ; j++ )
            scanf ( "%d", &arr[ i ][ j ] );
    }

    printf ( "\nThe matrix formed is....\n" );
    for ( i = 0 ; i <= 2 ; i++ )
    {
        for ( j = 0 ; j <= 2 ; j++ )
            printf ( "%d ", arr[ i ][ j ] );
        printf ( "\n" );
    }

    /* Check for symmetry */
    for ( i = 0 ; i <= 2 ; i++ )
    {
        for ( j = i ; j <= 2 ; j++ )
        {
            if ( arr[ i ][ j ] == arr[ j ][ i ] )
                count++ ;
        }
    }
}

```

```
    if ( count == 6 )
        printf ( "\n\nThe matrix is symmetric\n" );
    else
        printf ( "\n\nThe matrix is not symmetric\n" );

    return 0 ;
}
```

- (i) Write a program to add two 6 x 6 matrices.

Program:

```
/* Program to add two 6 x 6 matrices */
# include <stdio.h>

int main( )
{
    int mat1[ 6 ][ 6 ], mat2[ 6 ][ 6 ], mat3[ 6 ][ 6 ], i, j ;

    printf ( "\nEnter values for first 6 x 6 matrix:\n" );
    for ( i = 0 ; i <= 5 ; i++ )
    {
        for ( j = 0 ; j <= 5 ; j++ )
            scanf ( "%d", &mat1[ i ][ j ] ); /* Enter 1st Matrix values */
    }
    printf ( "\nEnter values for second 6 x 6 matrix:\n" );
    for ( i = 0 ; i <= 5 ; i++ )
    {
        for ( j = 0 ; j <= 5 ; j++ )
            scanf ( "%d", &mat2[ i ][ j ] ); /* Enter 2nd Matrix values */
    }

    /* print both matrices as entered */
    printf ( "\nMatrices entered by you are: \nMatrix 1:\n" );
    for ( i = 0 ; i <= 5 ; i++ )
    {
```

```
        for ( j = 0 ; j <= 5 ; j++ )
            printf ( "%d\t", mat1[ i ][ j ] ) ; /* print each row */

        printf ( "\n" ) ; /* new row on new line */
    }

    printf ( "\nMatrix 2:\n" ) ;
    for ( i = 0 ; i <= 5 ; i++ )
    {
        for ( j = 0 ; j <= 5 ; j++ )
            printf ( "%d\t", mat2[ i ][ j ] ) ; /* print each row */

        printf ( "\n" ) ; /* new row on new line */
    }

    /* Calculate the sum of two matrices */
    for ( i = 0 ; i <= 5 ; i++ )
    {
        for ( j = 0 ; j <= 5 ; j++ )
            mat3[ i ][ j ] = mat1[ i ][ j ] + mat2[ i ][ j ] ;
    }

    /* print the matrix with the sum */
    printf ( "\nThe new matrix after addition of the above two
            matrices is:\n" ) ;

    for ( i = 0 ; i <= 5 ; i++ )
    {
        for ( j = 0 ; j <= 5 ; j++ )
            printf ( "%d\t", mat3[ i ][ j ] ) ;

        printf ( "\n" ) ;
    }

    return 0 ;
}
```

- (j) Write a program to multiply any two 3 x 3 matrices.

Program:

```
/* Program to multiply two 3 x 3 matrices */
#include <stdio.h>

int main( )
{
    int mat1[ 3 ][ 3 ], mat2[ 3 ][ 3 ], mat3[ 3 ][ 3 ], i, j, k, sum ;

    /* get values for first matrix */
    printf ( "\nEnter values for first 3 x 3 matrix:\n" ) ;
    for ( i = 0 ; i <= 2 ; i++ )
    {
        for ( j = 0 ; j <= 2 ; j++ )
            scanf ( "%d", &mat1[ i ][ j ] ) ;
    }

    /* get values for second matrix */
    printf ( "\nEnter values for second 3 x 3 matrix:\n" ) ;
    for ( i = 0 ; i <= 2 ; i++ )
    {
        for ( j = 0 ; j <= 2 ; j++ )
            scanf ( "%d", &mat2[ i ][ j ] ) ;
    }

    /* print the first matrix as entered */
    printf ( "\nThe first 3 x 3 matrix entered by you is:\n" ) ;
    for ( i = 0 ; i <= 2 ; i++ )
    {
        for ( j = 0 ; j <= 2 ; j++ )
            printf ( "%d\t", mat1[ i ][ j ] ) ;

        printf ( "\n" ) ;
    }
}
```



```
/* print the second matrix as entered */
printf ( "\nThe second 3 x 3 matrix entered by you is:\n" );
for ( i = 0 ; i <= 2 ; i++ )
{
    for ( j = 0 ; j <= 2 ; j++ )
        printf ( "%d\t", mat2[ i ][ j ] );

    printf ( "\n" );
}

/* calculate the product of the two matrices */
for ( i = 0 ; i <= 2 ; i++ )
{
    for ( j = 0 ; j <= 2 ; j++ )
    {
        sum = 0 ;
        for ( k = 0 ; k <= 2 ; k++ )
            sum = sum + mat1[ i ][ k ] * mat2[ k ][ j ] ;
        mat3[ i ][ j ] = sum ;
    }
}

/* print the new matrix containing the product */
printf ( "\nThe product of the above two matrices is:\n" );
for ( i = 0 ; i <= 2 ; i++ )
{
    for ( j = 0 ; j <= 2 ; j++ )
        printf ( "%d\t", mat3[ i ][ j ] );

    printf ( "\n" );
}

return 0 ;
}
```

- (k) Given an array **p[5]**, write a function to shift it circularly left by two positions. Thus, if $p[0] = 15$, $p[1] = 30$, $p[2] = 28$, $p[3] = 19$ and $p[4] = 61$ then after the shift $p[0] = 28$, $p[1]$

= 19, p[2] = 61, p[3] = 15 and p[4] = 30. Call this function for a (4 x 5) matrix and get its rows left shifted.

Program:

```
/* Circular rotation of array elements and its use in matrix */
# include <stdio.h>

void swap ( int * );

int main( )
{
    int p[ 4 ][ 5 ];
    int i, j;

    /* Enter data for a matrix */
    for ( i = 0 ; i <= 3 ; i++ )
    {
        printf ( "\nEnter the %d row elements:\n", i );
        for ( j = 0 ; j <= 4 ; j++ )
        {
            scanf ( "%d", &p[ i ][ j ] );
        }
    }

    /* Print matrix as entered */
    printf ( "\nMatrix elements as entered:" );
    for ( i = 0 ; i <= 3 ; i++ )
    {
        printf ( "\nThe %d row elements: ", i );

        for ( j = 0 ; j <= 4 ; j++ )
        {
            printf ( "\t%d", p[ i ][ j ] );
        }
    }
    printf ( "\n" );
}
```

```

/* Function call to left shift rows */
swap ( p ); /* Base address of array passed to function */

/* Print new matrix after left shifting */
printf ( "\nMatrix after left shifting the row elements:" );
for ( i = 0 ; i <= 3 ; i++ )
{
    printf ( "\nThe %d row elements: ", i );
    for ( j = 0 ; j <= 4 ; j++ )
        printf ( "\t%d", p[ i ][ j ] );
}
return 0 ;
}

/* Function for left shifting of the rows */
void swap ( int *p )
{
    int k, i, tt, t, j ;
    for ( k = 0 ; k <= 3 ; k++ ) /* 4 rows to be shifted */
    {
        for ( i = 0 ; i <= 1 ; i++ ) /* shifting done twice */
        {
            t = *( p + k * 5 + 0 ) ;
            for ( j = 0 ; j <= 3 ; j++ )
            {
                tt = *( p + k * 5 + j ) ;
                *( p + k * 5 + j ) = *( p + k * 5 + j + 1 ) ;
                *( p + k * 5 + j + 1 ) = tt ;
            }
            *( p + k * 5 + j ) = t ;
        }
    }
}

```

- (1) A 6 x 6 matrix is entered through the keyboard. Write a program to obtain the Determinant value of this matrix.

Program:

```
/* Determinant of a n x n matrix */
/* The logic used here is: to evaluate a n x n determinant we multiply
   the first row elements of this determinant with a corresponding n-1 x
   n-1 determinant by first copying the n-1 x n-1 determinant into pre-
   allocated memory. We continue this process recursively till we reach
   a 1 x 1 determinant and then retrace back the steps. */

#include <stdlib.h>
#include <malloc.h>

void detmat ( int *, int );

int main( )
{
    int *arr, sum, n, i, j, pos, num ;

    printf ( "\nEnter value of n for ( n x n ) matrix " ) ;
    scanf ( "%d", &n ) ;
    /* allocate memory to accommodate the determinant */
    arr = calloc ( n * n, 2 ) ;

    printf ( "\nEnter numbers :\n" ) ;
    for ( i = 0 ; i < n ; i++ )
    {
        for ( j = 0 ; j < n ; j++ )
        {
            scanf ( "%d", &num ) ;
            pos = i * n + j ;
            arr[ pos ] = num ;
        }
    }
    /* Print the matrix as entered */
    for ( i = 0 ; i < n ; i++ )
    {
        for ( j = i ; j < n*n ; j += n )
        {
```

```

        printf ( "%d\t", arr[ j ] );
    }
    printf ( "\n" );
}

sum = detmat ( arr, n );
free ( arr ); /* Memory used by arr is freed */

printf ( "\n%d", sum );

return 0 ;
}

/* Function to calculate determinant */
void detmat ( int *arr, int order )
{
    int sign = 1, sum = 0, i, j, k, count, *arr2 ;
    int newsize, newpos, pos ;

    if ( order == 1 )
        return ( arr[ 0 ] );

    for ( i = 0 ; i < order ; i++, sign *= -1 )
    {
        /* copy n-1 by n-1 array into another array */
        newsize = ( order - 1 ) * ( order - 1 );
        arr2 = calloc ( newsize, 2 ); /*allocate memory for new array */
        for ( j = 1 ; j < order ; j++ )
        {
            for ( k = 0, count = 0 ; k < order ; k++ )
            {
                if ( k == i )
                    continue ;

                pos = j * order + k ;
                newpos = ( j - 1 ) * ( order - 1 ) + count ;

                arr2[ newpos ] = arr[ pos ] ;
            }
        }
    }
}

```

```

        count++;
    }
}

/* find determinant value of n-1 by n-1 array and add it to sum */
sum = sum + arr[ i ] * sign * detmat ( arr2, order - 1 );
free ( arr2 ); /* Free the memory used by the second array */
}
return ( sum );
}

```

- (m) For the following set of sample data, compute the standard deviation and the mean.

-6, -12, 8, 13, 11, 6, 7, 2, -6, -9, -10, 11, 10, 9, 2

The formula for standard deviation is

$$\frac{\sqrt{(x_i - \bar{x})^2}}{n}$$

where x_i is the data item and \bar{x} is the mean.

Program:

```

/* Computation of standard deviation */
# include <stdio.h>
# include <math.h>

int main( )
{
    int data[ 15 ] = { -6, -12, 8, 13, 11, 6, 7, 2, -6, -9, 2, 11, 10, 9, -10 };
    float xi, std[ 15 ], mean = 0 ;
    int i, n = 15 ;

    /* print data items */
    for ( i = 0 ; i <= 14 ; i++ )
    {

```

```

        printf ( "%d\t", data[ i ] );
    }

    /* Calculate mean for given data */
    for ( i = 0 ; i <= 14 ; i++ )
        mean = mean + data[ i ];

    mean = mean / n ;

    /* Calculate standard deviation */
    for ( i = 0 ; i <= 14 ; i++ )
        std[ i ] = sqrt ( pow ( ( data[ i ] - mean ), 2 ) ) / n ;

    /* Print result */
    printf ( "\n\n Mean = %f\n\n", mean ) ;
    for ( i = 0 ; i <= 14 ; i++ )
        printf ( "\nStandard Deviation of %d = %f\n", data[ i ], std[ i ] ) ;

    return 0 ;
}

```

- (n) The area of a triangle can be computed by the sine law when 2 sides of the triangle and the angle between them are known.

$$\text{Area} = (1 / 2) ab \sin (\text{angle})$$

Given the following 6 triangular pieces of land, write a program to find their area and determine which is largest.

Plot No.	a	b	Angle
1	137.4	80.9	0.78
2	155.2	92.62	0.89
3	149.3	97.93	1.35
4	160.0	100.25	9.00
5	155.6	68.95	1.25
6	149.7	120.0	1.75

Program:

```

/* Calculate Area = ( 1 / 2 ) ab sin ( angle ) */
# include <stdio.h>
# include <math.h>

int main( )
{
    float t, a[ 6 ], b[ 6 ], angle[ 6 ], area[ 6 ], largest = 0.0 ;
    int i, plot ;

    for ( i = 0 ; i <= 5 ; i++ )
    {
        printf ( "\nEnter the values of the following data:" ) ;
        printf ( "\na%d = ", i + 1 ) ;
        scanf ( "%f", &a[ i ] ) ;
        printf ( "\nb%d = ", i + 1 ) ;
        scanf ( "%f", &b[ i ] ) ;
        printf ( "\nangle%d = ", i + 1 ) ;
        scanf ( "%f", &angle[ i ] ) ;

        /* Calculate area */
        area[ i ] = ( 1.0 / 2 ) * a[ i ] * b[ i ] * sin ( angle[ i ] ) ;

        /* Note the largest value of area */
        if ( area[ i ] > largest )
        {
            largest = area[ i ] ;
            plot = i ; /* note the element with largest value of area */
        }
    }

    /* Print area of all plots */
    printf ( "\n\nEntered Plot dimensions and respective Area is:\n" ) ;
    printf ( "\nPlot No.\t\t\tAngle\tArea" ) ;
    for ( i = 0 ; i <= 5 ; i++ )
    {
        printf ( "\n%d\t\t\t%.2f\t%.2f\t%.2f\t%.3f ", i+1, a[ i ], b[ i ],

```



```

        angle[ i ], area[ i ] );
    }

    printf ( "\n\nLargest Triangular Area = %.3f having values of a, b and
            angle as:", largest );
    printf ( "\n\na = %.2f\tb = %.2f\tangle = %.2f ", a[ plot ], b[ plot ],
            angle[ plot ] );

    return 0 ;
}

```

- (o) For the following set of n data points (x, y), compute the correlation coefficient r, given by

$$r = \frac{\sum xy - \sum x \sum y}{\sqrt{[n \sum x^2 - (\sum x)^2][n \sum y^2 - (\sum y)^2]}}$$

x	y
34.22	102.43
39.87	100.93
41.85	97.43
43.23	97.81
40.06	98.32
53.29	98.32
53.29	100.07
54.14	97.08
49.12	91.59
40.71	94.85
55.15	94.65

Program:

```

/* Calculation correlation coefficient */
# include <stdio.h>
# include <math.h>

int main( )

```

```

{
    int n = 11, i, j ;
    float x[ 11 ] = { 34.22, 39.87, 41.85, 43.23, 40.06, 53.29, 53.29,
                     54.14, 49.12, 40.71, 55.15 } ;
    float y[ 11 ] = { 102.43, 100.93, 97.43, 97.81, 98.32, 98.32, 100.07,
                     97.08, 91.59, 94.85, 94.65 } ;

    float r ;
    float sx = 0.0, sxy = 0.0, sy = 0.0, sxs = 0.0, sys = 0.0 ;
    float r1, r2 ;

    for ( i = 0 ; i <= 10 ; i++ )
    {
        sx = sx + x[ i ] ; /* Summation of X */
        sxy = sxy + x[ i ] * y[ i ] ; /* Summation of XY */
        sy = sy + y[ i ] ; /* Summation of Y */
        sxs = sxs + x[ i ] * x[ i ] ; /* Summation of square of X */
        sys = sys + y[ i ] * y[ i ] ; /* Summation of square of Y */
    }

    printf ( "\n\n%c X  = %.2f\n", 228, sx ) ;
    printf ( "%c Y  = %.2f\n", 228, sy ) ;
    printf ( "%c XY  = %.2f\n", 228, sxy ) ;
    printf ( "%c X*X = %.2f\n", 228, sxs ) ;
    printf ( "%c Y*Y = %.2f\n", 228, sys ) ;
    r1 = ( sxy - sx * sy ) ;
    r2 = ( sqrt ( ( n * sxs - sx * sx ) * ( n * sys - sy * sy ) ) ) ;
    r = r1 / r2 ;
    printf ( "\n\n( Numerator ) r1 = %f\n", r1 ) ;
    printf ( "( Denominator) r2 = %f\n", r2 ) ;
    printf ( "Corelation coefficient r1/r2 = %f\n", r ) ;

    return 0 ;
}

```

- (p) For the following set of point given by (x, y) fit a straight line given by

$$y = a + bx$$

where,

$$a = \bar{y} - b\bar{x} \quad \text{and}$$

$$b = \frac{n \sum yx - \sum x \sum y}{[n \sum x^2 - (\sum x)^2]}$$

x	Y
3.0	1.5
4.5	2.0
5.5	3.5
6.5	5.0
7.5	6.0
8.5	7.5
8.0	9.0
9.0	10.5
9.5	12.0
10.0	14.0

Program:

```
/* Equation of a straight line */
#include <stdio.h>
#include <math.h>

int main( )
{
    int n = 10, i;
    float x[ 10 ] = { 3.0, 4.5, 5.5, 6.5, 7.5, 8.5, 8.0, 9.0, 9.5, 10.0 };
    float y[ 10 ] = { 1.5, 2.0, 3.5, 5.0, 6.0, 7.5, 9.0, 10.5, 12.0, 14.0 };
    float a, b;
    float sx = 0.0, sxy = 0.0, sy = 0.0, sxs = 0.0;
    float r1, r2, mx = 0.0, my = 0.0, yy;

    for ( i = 0; i <= 9; i++ )
    {
```

```

        sx = sx + x[ i ] ; /* Summation of X */
        sxy = sxy + x[ i ] * y[ i ] ; /* Summation of XY */
        sy = sy + y[ i ] ; /* Summation of Y */
        sxs = sxs + x[ i ] * x[ i ] ; /* Summation of square of X */
    }

    printf ( "\n\n%c X = %.2f\n", 228, sx ) ;
    printf ( "%c Y = %.2f\n", 228, sy ) ;
    printf ( "%c XY = %.2f\n", 228, sxy ) ;
    printf ( "%c X*X = %.2f\n", 228, sxs ) ;

    r1 = ( n * sxy - sx * sy ) ;
    r2 = ( ( n * sxs ) - ( sx * sx ) ) ;
    b = r1 / r2 ;
    printf ( "\n\nr1 = %f\n", r1 ) ;
    printf ( "r2 = %f\n", r2 ) ;
    printf ( "Value of b = %f\n", b ) ;
    mx = sx / n ; /* mean of x */
    my = sy / n ; /* mean of y */
    a = my - b * mx ;
    printf ( "Value of a = %f\n", a ) ;
    printf ( "Equation of the line is : Y = %.2f* X %+.2f\n", b , a ) ;

    return 0 ;
}

```

- (q) The **X** and **Y** coordinates of 10 different points are entered through the keyboard. Write a program to find the distance of last point from the first point (sum of distances between consecutive points).

Program:

```

/* Distance between two points */
# include <stdio.h>
# include <math.h>

```

```

int main( )
{
    int i, x[ 10 ], y[ 10 ];
    float sum = 0 ;

    printf ( "\nEnter the coordinates for the points: " );
    for ( i = 0 ; i <= 9 ; i++ )
    {
        printf ( "\nX[ %d ] = ", i + 1 );
        scanf ( "%d", &x[ i ] );

        printf ( "\nY[ %d ] = ", i + 1 );
        scanf ( "%d", &y[ i ] );
    }

    for ( i = 0 ; i <= 8 ; i++ )
        sum = sum + sqrt ( pow ( ( x[ i + 1 ] - x[ i ] ), 2 ) + pow ( (
            y[ i + 1 ] - y[ i ] ), 2 ) );

    printf ( "\n\nDistance of the last point from the first point = %.2f\n",
        sum );

    return 0 ;
}

```

- (r) A dequeue is an ordered set of elements in which elements may be inserted or retrieved from either end. Using an array simulate a dequeue of characters and the operations retrieve left, retrieve right, insert left, insert right. Exceptional conditions such as dequeue full or empty should be indicated. Two pointers (namely, left and right) are needed in this simulation.

Program:

```

/* Implementation of a deque using an array */
#include <stdio.h>

```

```
/* Function prototypes */
void add_front ( int );
void add_rear ( int );
int retrieve_front ( void );
int retrieve_rear ( void );
void display ( void );

/* Global variables */
int *front, *rear ;
int a[ 26 ] ;

int main( )
{
    int item ;
    front = NULL ;
    rear = NULL ;

    printf ( "\n\nAdding elements at front of a deque: " ) ;
    add_front ( 10 ) ;
    add_front ( 40 ) ;
    add_front ( 30 ) ;
    display ( ) ;

    printf ( "\n\nAdding an element at the rear of a deque: " ) ;
    add_rear ( 50 ) ;
    display ( ) ;

    printf ( "\n\nRetreiving an element from the front of a deque: " ) ;
    item = retrieve_front ( ) ;
    if ( item == -1 )
        printf ( "\nDeQueue Empty " ) ;
    else
        printf ( "\n\nFront Item = %d ", item ) ;
    display ( ) ;

    printf ( "\n\nRetreiving an element from the rear of a deque: " ) ;
    item = retrieve_rear ( ) ;
```

```
    if ( item == -1 )
        printf ( "\nDeQueue Empty " );
    else
        printf ( "\n\nRear Item = %d ", item );
    display( ) ;

    return 0 ;
}
```

```
/* Function to retrieve item from rear */
int retrieve_rear ( void )
{
    int item, i, j ;
    if ( rear == NULL )
    {
        printf ( "\n DeQueue Empty " );
        return -1 ;
    }
    else
    {
        item = *rear ;
        i = rear - front ;
        if ( i == 0 )
        {
            front = NULL ;
            rear = NULL ;
        }
        else
        {
            *rear = 0 ;
            rear-- ;
        }
    }
    return item ;
}
```

```
/* Function to retrieve item from front */
int retrieve_front ( void )
```

```
{
    int item, i, j ;
    if ( front == NULL )
    {
        printf ( "\n DeQueue Empty " );
        return -1 ;
    }
    else
    {
        item = *front ;
        i = rear - front ;
        if ( i == 0 )
        {
            front = NULL ;
            rear = NULL ;
        }
        else
        {
            for ( j = 0 ; j <= i - 1 ; j ++ )
                front [ j ] = front [ j + 1 ] ;
            *rear = 0 ;
            rear-- ;
        }
    }
    return item ;
}
```

/* Function to add item to rear */

```
void add_rear ( int item )
{
    int i, j ;
    if ( front == NULL )
    {
        front = a ;
        *front = item ;
        rear = a ;
    }
    else
```



```
{
    i = rear - front ;

    if ( i != 25 )
    {
        rear++ ;
        *rear = item ;
    }
    else
        printf ( "\nDeQueue full " ) ;
}

}

/* Function to add item at front */
void add_front ( int item )
{
    int i, j ;
    if ( front == NULL )
    {
        front = a ;
        *( front ) = item ;
        rear = a ;
    }
    else
    {
        front = a ;
        j = rear - front ;
        if ( j != 25 )
        {
            for ( i = j + 1 ; i >= 0 ; i-- )
                front [ i ] = front [ i - 1 ] ;
            *( front + 0 ) = item ;
            rear++ ;
        }
        else
            printf ( "\n DeQueue Full " ) ;
    }
}
```

```
/* Function to display the deque */
void display ( void )
{
    int i ;
    int *p = front ;
    if ( p == NULL )
    {
        printf ( "\n\nDeQueue Empty " ) ;
    }
    else
    {
        printf ( "\n" ) ;
        for ( i = 0 ; i <= ( rear - front ) ; i++ )
            printf ( "\n a[ %d ] = %d ", i, *p++ ) ;
    }
}
```

- (s) Sudoku is a popular number-placement puzzle. The objective is to fill a 9×9 grid with digits so that each column, each row, and each of the nine 3×3 sub-grids that compose the grid contains all of the digits from 1 to 9. The puzzle setter provides a partially completed grid, which typically has a unique solution. One such solution is given below. Write a program to check whether the solution is correct or not.

5	3	4	6	7	8	9	1	2
6	7	2	1	9	5	3	4	8
1	9	8	3	4	2	5	6	7
8	5	9	7	6	1	4	2	3
4	2	6	8	5	3	7	9	1
7	1	3	9	2	4	8	5	6
9	6	1	5	3	7	2	8	4
2	8	7	4	1	9	6	3	5
3	4	5	2	8	6	1	7	9

Program:

```

/* Check Sudoku solution */
#include <stdio.h>

int main( )
{
    int a[ ][ 9 ] = {
        5, 3, 4, 6, 7, 8, 9, 1, 2,
        6, 7, 2, 1, 9, 5, 3, 4, 8,
        1, 9, 8, 3, 4, 2, 5, 6, 7,
        8, 5, 9, 7, 6, 1, 4, 2, 3,
        4, 2, 6, 8, 5, 3, 7, 9, 1,
        7, 1, 3, 9, 2, 4, 8, 5, 6,

```

```
        9, 6, 1, 5, 3, 7, 2, 8, 4,  
        2, 8, 7, 4, 1, 9, 6, 3, 5,  
        3, 4, 5, 2, 8, 6, 1, 7, 9  
    };  
  
    int i, j;  
    int sum ;  
  
    /* check rows */  
    for ( i = 0 ; i <= 8 ; i++ )  
    {  
        sum = 0 ;  
        for ( j = 0 ; j <= 8 ; j++ )  
            sum = sum + a[ i ][ j ] ;  
  
        if ( sum != 45 )  
        {  
            printf ( "Problem in row = %d\n", i ) ;  
            return 1 ;  
        }  
    }  
  
    printf ( "All rows are correct\n" ) ;  
  
    /* check columns */  
    for ( j = 0 ; j <= 8 ; j++ )  
    {  
        sum = 0 ;  
        for ( i = 0 ; i <= 8 ; i++ )  
            sum = sum + a[ i ][ j ] ;  
  
        if ( sum != 45 )  
        {  
            printf ( "Problem in column = %d\n", j ) ;  
            return 2 ;  
        }  
    }  
}
```

```
printf ( "All columns are correct\n" );  
return 0 ;  
}
```

CHAPTER FIFTEEN

Strings

[A] What will be the output of the following programs:

(a)

```
#include <stdio.h>
int main()
{
    char c[2] = "A";
    printf ("%c\n", c[0]);
    printf ("%s\n", c);
    return 0;
}
```

Output:

A
A

(b)

```
#include <stdio.h>
int main()
{
    char s[ ] = "Get organised! learn C!!";
    printf ("%s\n", &s[2]);
    printf ("%s\n", s);
    printf ("%s\n", &s);
    printf ("%c\n", s[2]);
    return 0;
}
```

```
}

```

Output:

```
t organised ! learn c !!
get organised ! learn c !!
get organised ! learn c !!
t

```

```
(c) #include <stdio.h>
int main( )
{
    char s[ ] = "No two viruses work similarly" ;
    int i = 0 ;
    while ( s[i] != 0 )
    {
        printf ( "%c %c\n", s[i], *( s + i ) ) ;
        printf ( "%c %c\n", i[ s ], *( i + s ) ) ;
        i++ ;
    }
    return 0 ;
}

```

Output:

```
N N
N N
o o
o o
t t
t t
.....
.....
y y
y y

```

```
(d) #include <stdio.h>
int main( )

```

```
{
    char s[] = "Churchgate: no church no gate" ;
    char t[25] ;
    char *ss, *tt ;
    ss = s ;
    while ( *ss != '\0' )
        *tt++ = *ss++ ;
    printf ( "%s\n", t ) ;
    return 0 ;
}
```

Output:

The code causes an exception as The variable 'tt' is being used without being initialized.

```
(e) # include <stdio.h>
int main( )
{
    char str1[] = { 'H', 'e', 'l', 'l', 'o', 0 } ;
    char str2[] = "Hello" ;
    printf ( "%s\n", str1 ) ;
    printf ( "%s\n", str2 ) ;
    return 0 ;
}
```

Output:

Hello
Hello

```
(f) # include <stdio.h>
void main( )
{
    printf ( 5 + "Good Morning " ) ;
    return 0 ;
}
```


Output:

Morning

```
(g) # include <stdio.h>
    int main( )
    {
        printf ( "%c\n", "abcdefgh"[ 4 ] );
        return 0 ;
    }
```

Output:

e

```
(h) # include <stdio.h>
    int main( )
    {
        printf ( "%d %d %d\n", sizeof ( '3' ), sizeof ( "3" ), sizeof ( 3 ) );
        return 0 ;
    }
```

Output:

2 2 2

[B] Point out the errors, if any, in the following programs:

```
(a) # include <stdio.h>
    # include <string.h>
    int main( )
    {
        char *str1 = "United" ;
        char *str2 = "Front" ;
        char *str3 ;
        str3 = strcat ( str1, str2 ) ;
        printf ( "%s\n", str3 ) ;
        return 0 ;
    }
```

```
}
```

No Error

```
(b) #include <stdio.h>
int main( )
{
    int arr[ ] = { 'A', 'B', 'C', 'D' };
    int i ;
    for ( i = 0 ; i <= 3 ; i++ )
        printf ( "%d", arr[ i ] );
    printf ( "\n" );
    return 0 ;
}
```

No Error

```
(c) #include <stdio.h>
int main( )
{
    char arr[ 8 ] = "Rhombus";
    int i ;
    for ( i = 0 ; i <= 7 ; i++ )
        printf ( "%d", *arr );
        arr++ ;
    return 0 ;
}
```

Error. arr cannot be incremented.

[C] Fill in the blanks:

- (a) "A" is a string whereas 'A' is a character.
- (b) A string is terminated by a null character, which is written as \0.

- (c) The array **char name[10]** can consist of a maximum of 9 characters.
- (d) The array elements are always stored in consecutive memory locations.

[D] Attempt the following:

- (a) Which is more appropriate for reading in a multi-word string?

gets() printf() scanf() puts()

Answer:

gets()

- (b) If the string "Alice in wonder land" is fed to the following **scanf()** statement, what will be the contents of the arrays **str1**, **str2**, **str3** and **str4**?

scanf ("%s%s%s%s", str1, str2, str3, str4);

Answer:

str1 – Alice
str2 – in
str3 – wonder
str4 – land

- (c) Write a program that extracts part of the given string from the specified position. For example, if the sting is "Working with strings is fun", then if from position 4, 4 characters are to be extracted then the program should return string as "king". If the number of characters to be extracted is 0 then the program should extract entire string from the specified position.

Program:

```
/* To extract a substring from a string */
# include <stdio.h>
# include <string.h>

int main( )
{
    char str[ 20 ], news[ 20 ] ;
    char *s, *t ;
    int pos, n, i ;

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

    printf ( "\nEnter the position and number of characters to extract: ",
            news ) ;
    scanf ( "%d %d", &pos, &n ) ;

    s = str ;
    t = news ;

    if ( n == 0 )
        n = strlen ( str ) ;

    s = s + pos - 1 ;

    for ( i = 0 ; i < n ; i++ )
    {
        *t = *s ;
        s++ ;
        t++ ;
    }
    *t = '\0' ;

    printf ( "\nThe substring is: %s\n", news ) ;

    return 0 ;
```

```
}
```

- (d) Write a program that converts a string like "124" to an integer 124.

Program:

```
/* To convert a string to an integer */
/* A function atoi( ) converts string to an int */
#include <stdio.h>

int main( )
{
    char str[ 6 ] ;
    int num = 0, i ;

    printf ( "Enter a string containing a number: " ) ;
    scanf ( "%s", str ) ;

    for ( i = 0 ; str [ i ] != '\0' ; i++ )
    {
        if ( str[ i ] >= 48 && str[ i ] <= 57 )
            num = num * 10 + ( str[ i ] - 48 ) ;
        else
        {
            printf ( "Not a valid string\n" ) ;
            return 1 ;
        }
    }

    printf ( "\nThe number is: %d\n", num ) ;

    return 0 ;
}
```

- (e) Write a program that generates and prints the Fibonacci words of order 0 through 5. If $f(0) = "a"$, $f(1) = "b"$, $f(2) = "ba"$, $f(3) = "bab"$, $f(4) = "babba"$, etc.

Program:

```
/* Generate Fibonacci words of order 0 through 5 */
#include <stdio.h>
#include <string.h>

int main( )
{
    char str[ 50 ];
    char lastbutoneterm[ 50 ] = "A" ;
    char lastterm[ 50 ] = "B" ;
    int i ;

    for ( i = 1 ; i <= 5 ; i++ )
    {
        strcpy ( str, lastterm ) ;
        strcat ( str, lastbutoneterm ) ;
        printf ( "%s\n", str ) ;
        strcpy ( lastbutoneterm, lastterm ) ;
        strcpy ( lastterm, str ) ;
    }

    return 0 ;
}
```

- (f) To uniquely identify a book a 10-digit ISBN number is used. The rightmost digit is a checksum digit. This digit is determined from the other 9 digits using the condition that $d_1 + 2d_2 + 3d_3 + \dots + 10d_{10}$ must be a multiple of 11 (where d_i denotes the i^{th} digit from the right). The checksum digit d_1 can be any value from 0 to 10: the ISBN convention is to use the value X to denote 10. Write a program that receives a 10-digit

integer, computes the checksum, and reports whether the ISBN number is correct or not.

Program:

```
/* Check correctness of ISBN number */
#include <stdio.h>
#include <string.h>

int main( )
{
    char str[ 11 ];
    int i, j, sum ;

    printf ( "Enter 10 digit ISBN number: " );
    scanf ( "%s", str );

    j = 2 ;
    sum = 0 ;
    for ( i = 8 ; i >= 0 ; i-- )
    {
        sum = sum + ( str [ i ] - '0' ) * j ;
        j++ ;
    }

    for ( i = 0 ; i <= 9 ; i++ )
    {
        if ( ( sum + i ) % 11 == 0 )
            break ;
    }

    if ( i == str[ 9 ] - '0' )
        printf ( "ISBN Number is verified and found to be correct\n" );
    else
        printf ( "Checksum error in ISBN Number\n" );

    return 0 ;
}
```

}

- (g) A Credit Card number is usually a 16-digit number. A valid Credit Card number would satisfy a rule explained below with the help of a dummy Credit Card number—4567 1234 5678 9129. Start with the rightmost - 1 digit and multiply every other digit by 2.

4 5 6 7 1 2 3 4 5 6 7 8 9 1 2 9

8 12 2 6 10 14 18 4

Then subtract 9 from any number larger than 10. Thus we get:

8 3 2 6 1 5 9 4

Add them all up to get 38.

Add all the other digits to get 42.

Sum of 38 and 42 is 80. Since 80 is divisible by 10, the Credit Card number is valid.

Write a program that receives a Credit Card number and checks using the above rule whether the Credit Card number is valid.

Program:

```
/* Verify correctness of Credit Card Number */
#include <stdio.h>
#include <string.h>

int main( )
{
    int len, i, sum, digit, multiple ;
    char str[ 20 ] ;
```



```
printf ( "Enter the Credit Card number: " );
scanf ( "%s", str );
len = strlen ( str );
sum = 0 ;

for ( i = 15 ; i >= 0 ; i-- )
{
    digit = str[ i ] - '0';
    if ( i % 2 == 0 )
    {
        multiple = digit * 2 ;
        digit = multiple < 10 ? multiple : multiple - 9 ;
    }
    sum += digit ;
}

printf ( "%d\n", sum ) ;

if ( sum % 10 == 0 )
    printf ( "Valid credit card number\n" ) ;
else
    printf ( "Invalid credit card number\n" ) ;

return 0 ;
}
```

CHAPTER

SIXTEEN

Handling Multiple Strings

[A] Answer the following:

- (a) How many bytes in memory would be occupied by the following array of pointers to strings? How many bytes would be required to store the same strings, if they are stored in a two-dimensional character array?

```
char *mess[] = {  
    "Hammer and tongs",  
    "Tooth and nail",  
    "Spit and polish",  
    "You and C"  
};
```

Answer:

58 bytes for storing strings using array of pointers

68 bytes for storing strings using two dimensional array

- (b) Can an array of pointers to strings be used to collect strings from the keyboard? If yes, how? If not, why not?

Answer:

No, because when we use array of pointers it becomes necessary to initialize it at the time of declaration. And hence its storage class automatically becomes static.

[B] Attempt the following:

- (a) Write a program that uses an array of pointers to strings **str[]**. Receive two strings **str1** and **str2** and check if **str1** is embedded in any of the strings in **str[]**. If **str1** is found, then replace it with **str2**.

```
char *str[ ] = {  
    "We will teach you how to...",  
    "Move a mountain",  
    "Level a building",  
    "Erase the past",  
    "Make a million",  
    "...all through C!"  
};
```

For example if **str1** contains "mountain" and **str2** contains "car", then the second string in **str** should get changed to "Move a car".

Program:

```
/* To replace a substring */  
#include <stdio.h>  
#include <string.h>  
  
int main( )  
{  
    char str1[ 20 ], str2[ 20 ];  
    char *news, *t, *p;  
    int i;
```

```
char *str[ ] = {
    "We will teach you how to...",
    "Move a mountain",
    "Level a building",
    "Erase the past",
    "Make a million",
    "...all through C!"
};

printf ( "\nEnter the string to be replaced: " );
scanf ( "%s", str1 );

printf ( "\nEnter the new string: " );
scanf ( "%s", str2 );

/* Check the length of the new string */
if ( strlen ( str2 ) > strlen ( str1 ) )
{
    printf( "Enter a string with %d characters only\n", strlen( str1 ) );
    exit ( 0 );
}

for ( i = 0 ; i < 6 ; i++ ) /* Loop for number of strings */
{
    /* Find the entered string in the given array */
    p = strstr ( str[ i ], str1 );

    if ( p )
    {
        /* Copy the remaining string */
        news = p + strlen ( str1 );
        strcpy ( t, news );
        /* Replace the old string */
        strcpy ( p, str2 );
        /* Finally append the remaining part */
        strcat ( p, t );
        break ;
    }
}
```

```
    }

    printf ( "\nThe new string is: \n" );
    for( i = 0 ; i < 6 ; i++ ) /* Loop to print the strings */
        printf ( "%s\n", str[ i ] );

    return 0 ;
}
```

- (b) Write a program to sort a set of names stored in an array in alphabetical order.

Program:

```
/* To sort strings alphabetically */
# include <stdio.h>

int main( )
{
    char *str[] = {
        "Rajesh",
        "Ashish",
        "Milind",
        "Pushkar",
        "Akash"
    };

    char *t ;
    int i, j ;

    for ( i = 0 ; i < 5 ; i++ )
    {
        for ( j = i + 1 ; j < 5 ; j++ )
        {
            if ( ( strcmp ( str[ i ], str[ j ] ) ) > 0 )
            {
                t = str[ i ] ;
```

```

        str[ i ] = str[ j ] ;
        str[ j ] = t ;
    }
}

for ( i = 0 ; i < 5 ; i++ )
    printf ( "\n%s", str[ i ] ) ;

return 0 ;
}

```

- (c) Write a program to reverse the strings stored in the following array of pointers to strings:

```

char *s[ ] = {
    "To err is human...",
    "But to really mess things up...",
    "One needs to know C!!"
};

```

Program:

```

/* Reverse strings stored in an array of pointers */
# include <stdio.h>

void xstrrev ( char *ss ) ;

int main( )
{
    static char *s[ ] = {
        "To ere is human...",
        "But to really mess things up...",
        "One needs to know C !!"
    };

    int i ;

```

```
    for ( i = 0 ; i <= 2 ; i++ ) /* Three strings to be traversed */
    {
        xstrev ( s[ i ] );
        printf ( "%s\n", s[ i ] );
    }

    return 0 ;
}

void xstrev ( char *ss )
{
    int l, i ;
    char *tt, temp ;

    l = strlen ( ss ) ;
    tt = ss + l - 1 ;

    for ( i = 1 ; i <= l / 2 ; i++ )
    {
        temp = *ss ;
        *ss = *tt ;
        *tt = temp ;
        ss++ ;
        tt-- ;
    }
}
```

- (d) Develop a program that receives the month and year from the keyboard as integers and prints the calendar in the following format.

March 2006						
Mon	Tue	Wed	Thu	Fri	Sat	Sun
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Note that according to the Gregorian calendar 01/01/1900 was Monday. With this as the base the calendar should be generated.

Program:

```
/* Program to display calendar of any year */
#include <stdio.h>
#include <windows.h>

void cal ( int yr, int mo, int fd, int da );
void gotoxy ( short int col, short int row );

static char *months[ ] = {
    "January", "February", "March",
    "April", "May", "June",
    "July", "August", "September",
    "October", "November", "December"
};

int main( )
{
```



```

static int days[ 12 ]={ 31, 28, 31, 30, 31, 30, 31, 31, 30, 31, 30, 31 };
long int  ndays, ldays, tydays, tdays ;
int  d, i, m, fday, y ;
char  ch ;

printf ( "\nEnter year(1900 onwards) & month (number): " ) ;
scanf ( "%d %d", &y, &m ) ;

ndays = ( y - 1 ) * 365l ;
ldays = ( y - 1 ) / 4 - ( y - 1 ) / 100 + ( y - 1 ) / 400 ;
tdays = ndays + ldays ;

if ( ( y % 100 == 0 && y % 400 == 0 ) || ( y % 4 == 0 &&
    y % 100 != 0 ) )
    days[ 1 ] = 29 ;
else
    days[ 1 ] = 28 ;

d = days[ m - 1 ] ;
tydays = 0 ;

for ( i = 0 ; i <= m - 2 ; i++ )
    tydays = tydays + days[ i ] ;

tdays = tydays + tdays ;
fday = tdays % 7 ;
cal ( y, m, fday, d ) ;

return 0 ;
}

void cal ( int yr, int mo, int fd, int da )
{
    int  i, r, c ;
    char  a ;

    gotoxy ( 25, 2 ) ;
    printf ( "%s %d", months[ mo - 1 ], yr ) ;

```

```
gotoxy ( 5, 5 );
printf ( "-----" );

gotoxy ( 10, 6 );
printf ( "Mon Tue Wed Thu Fri Sat Sun" );

gotoxy ( 5, 7 );
printf ( "-----" );

r = 9;
c = 11 + 6 * fd ;
for ( i = 1 ; i <= da ; i++ )
{
    gotoxy ( c, r );
    printf ( "%d", i );

    if ( c <= 41 )
        c = c + 6 ;
    else
    {
        c = 11 ;
        r = r + 1 ;
    }
}

gotoxy ( 5, 15 );
printf ( "-----" );
}

void gotoxy ( short int col, short int row )
{
    HANDLE hStdout = GetStdHandle ( STD_OUTPUT_HANDLE );
    COORD position = { col, row } ;
    SetConsoleCursorPosition ( hStdout, position ) ;
}
```

- (e) A factory has 3 division and stocks 4 categories of products. An inventory table is updated for each division and for each product as they are received. There are three independent suppliers of products to the factory:
- (a) Design a data format to represent each transaction.
 - (b) Write a program to take a transaction and update the inventory.
 - (c) If the cost per item is also given write a program to calculate the total inventory values.

Program:

```
/* Inventory Management */
#include <stdio.h>

int main( )
{
    int *inven[ 3 ][ 4 ]; /* 3 divisions and 4 categories */
    int comp[ 3 ];
    int *c;
    char ch = 'y';
    int t, i, j, pno, d, comp_no;
    int tot = 0, cost[ 4 ] = { 100, 200, 300, 400 };
    long int tot_in_val = 0;

    for ( i = 0 ; i <= 2 ; i++ )
    {
        for ( j = 0 ; j <= 3 ; j++ )
        {
            c = ( int* ) malloc ( sizeof ( int ) * 3 );
            inven[ i ][ j ] = c;
            *( inven[ i ][ j ] + 0 ) = 0;
            *( inven[ i ][ j ] + 1 ) = 0;
            *( inven[ i ][ j ] + 2 ) = 0;
        }
    }
}
```

```

    }
}

while ( ch == 'y' || ch == 'Y' )
{
    printf ( "\nEnter the Division 0, 1 or 2: " );
    scanf ( "%d", &d );

    if ( d < 0 || d > 2 )
    {
        printf ( "\nInvalid Division" );
        continue ;
    }

    printf ( "\nSelect product number\nfrom 0, 1, 2 or 3 which  
represents its category: " );
    scanf ( "%d", &pno );

    if ( pno < 0 || pno > 3 )
    {
        printf ( "Invalid Division\n" );
        continue ;
    }

    printf ( "\nEnter the company number 0, 1, 2\nfrom where  
the product is purchased: " );
    scanf ( "%d", &comp_no );

    if ( comp_no >= 0 && comp_no <= 2)*( inven[ d ][ pno ] +  
comp_no ) = *( inven[ d ][ pno ] + comp_no ) + 1 ;
    else
    {
        printf ( "Invalid Company number\n" );
        continue ;
    }

    printf ( "\n\n\t\t Want to enter another data ( y / n )\n\t\t " );
    fflush ( stdin );

```

```

scanf ( "%c", &ch );
fflush ( stdin );
}

printf ( "\ntotal quantity of products present in each divisions are: " );
printf ( "\nProduct \t0\t1\t2\t3\n" );
for ( i = 0 ; i <= 2 ; i++ )
{
    printf ( "\nDivision No %d", i );
    for ( j = 0 ; j <= 3 ; j++ )
    {
        t = *( inven[ i ][ j ] + 0 ) + *( inven[ i ][ j ] + 1 ) +
            *( inven[ i ][ j ] + 2 );
        printf ( "\t%d", t );
    }
    printf ( "\n" );
}

printf ( "\nTotal cost of products present in each divisions are:\n" );

for ( i = 0 ; i <= 2 ; i++ )
{
    printf ( "\nDivision No %d", i + 1 );
    for ( j = 0 ; j <= 3 ; j++ )
    {
        t = *( inven[ i ][ j ] + 0 ) + *( inven[ i ][ j ] + 1 ) +
            *( inven[ i ][ j ] + 2 );
        tot = tot + t * cost[ j ];
    }
    printf ( "\tRs. %d ", tot );
    printf ( "\n" );
    tot_in_val = tot_in_val + tot ;
    tot = 0 ;
}

printf ( "\n\n Total inventory cost = %ld", tot_in_val );

```

```
    return 0 ;  
}
```

- (f) Modify the above program suitably so that once the calendar for a particular month and year has been displayed on the screen, then using arrow keys the user must be able to change the calendar in the following manner:

Up arrow key : Next year, same month
Down arrow key : Previous year, same month
Right arrow key : Same year, next month
Left arrow key : Same year, previous month

If the escape key is hit then the procedure should stop.

Hint: Use the **getkey()** function discussed in Chapter 14, problem number [C](d).

Program:

```
/* Program to display calendar of any year */  
  
#include <stdio.h>  
#include <conio.h>  
#include <windows.h>  
  
void cal ( int yr, int mo, int fd, int da ) ;  
void gotoxy ( short int col, short int row ) ;  
  
char *months[ ] = {  
    "January", "February", "March",  
    "April", "May", "June",  
    "July", "August", "September",  
    "October", "November", "December"  
};  
  
int main( )
```

```

{
    int days[ 12 ]={ 31, 28, 31, 30, 31, 30, 31, 31, 30, 31, 30, 31 };
    long int ndays, ldays, tydays, tdays ;
    int d, i, m, fday, y ;
    char ch ;

    printf ( "\nEnter year(1900 onwards) & month (number): " );
    scanf ( "%d %d", &y, &m );

    while ( 1 )
    {
        ndays = ( y - 1 ) * 365l ;
        ldays = ( y - 1 ) / 4 - ( y - 1 ) / 100 + ( y - 1 ) / 400 ;
        tdays = ndays + ldays ; /* Total days */

        /* check for leap year */
        if ( ( y % 100 == 0 && y % 400 == 0 ) ||
            ( y % 4 == 0 && y % 100 != 0 ) )
            days[ 1 ] = 29 ; /* days[ 1 ] = February */
        else
            days[ 1 ] = 28 ;

        d = days[ m - 1 ] ;
        tydays = 0 ;

        for ( i = 0 ; i <= m - 2 ; i++ )
            tydays = tydays + days[ i ] ;

        tdays = tydays + tdays ;
        fday = tdays % 7 ;
        cal ( y, m, fday, d ) ;

        ch = getkey( ) ; /* collects keyboard input */

        switch ( ch )
        {
            case 77 : /* right arrow - next month */
                if ( m == 12 )

```

```
        {
            y++ ;
            m = 1 ;
        }
        else
            m++ ;
        break ;

case 72 : /* Up arrow - Next year */
    y++ ;
    continue ;

case 75 : /* Left Arrow - previous month */
    if ( m == 1 )
    {
        y-- ;
        m = 12 ;
    }
    else
        m-- ;
    break ;

case 80 : /* down arrow - previous year */
    y-- ;
    continue ;

case 1 : /* Escape to exit */
    exit ( 0 ) ;
    }
}
return 0 ;
}

void cal ( int yr, int mo, int fd, int da )
{
    int i, r, c ;
    char a ;
```



```
gotoxy ( 25, 2 );
printf ( "%s %d ", months[ mo - 1 ], yr );

gotoxy ( 5, 5 );
printf ( "-----" );

gotoxy ( 10, 6 );
printf ( "Mon Tue Wed Thu Fri Sat Sun" );

gotoxy ( 5, 7 );
printf ( "-----" );

r = 9 ;
c = 11 + 6 * fd ;
for ( i = 1 ; i <= da ; i++ )
{
    gotoxy ( c, r );
    printf ( "%d", i );

    if ( c <= 41 )
        c = c + 6 ;
    else
    {
        c = 11 ;
        r = r + 1 ;
    }
}

gotoxy ( 5, 15 );
printf ( "-----" );

gotoxy ( 11, 17 );
printf ( "UP - Next Year      DOWN - Prev Year" );

gotoxy ( 11, 18 );
printf ( "RIGHT - Next Month   LEFT - Prev Month" );

gotoxy ( 27, 20 );
```

```
        printf ( "Esc - Exit" );
    }

    int getkey( )
    {
        int ch ;
        ch = getch( ) ;
        if ( ch == 224 || 0 )
        {
            ch = getch( ) ;
            return ch ;
        }
        return ch ;
    }

    void gotoxy ( short int col, short int row )
    {
        HANDLE hStdout = GetStdHandle ( STD_OUTPUT_HANDLE );
        COORD position = { col, row };
        SetConsoleCursorPosition ( hStdout, position );
    }
```

- (g) Write a program to delete all vowels from a sentence. Assume that the sentence is not more than 80 characters long.

Program:

```
/* Delete all vowels from a sentence */
#include <stdio.h>
int main( )
{
    char str[ 80 ], str1[ 80 ];
    char *s, *p ;

    printf ( "\nEnter a sentence not more than 80 characters long:\n" );
    gets ( str );
```

```

s = str ; /* Base address of the string */
p = str1 ; /* Base address of new string */
while ( *s )
{
    if ( *s == 'a' || *s == 'e' || *s == 'i' || *s == 'o' || *s == 'u' )
        s++ ;
    else
        if ( *s == 'A' || *s == 'E' || *s == 'I' || *s == 'O' || *s == 'U' )
            s++ ;
        else
            *p++ = *s++ ;
}
*p = '\0' ;
printf ( "\n\nSentence after removing all vowels is:\n" ) ;
puts ( str1 ) ;

return 0 ;
}

```

- (h) Write a program that will read a line and delete from it all occurrences of the word 'the'.

Program:

```

/* Delete all occurrences of "the" from a sentence */
#include <stdio.h>

int main( )
{
    char str[ 80 ], str2[ 80 ] ;
    char *s, *q, *p ;
    int i ;

    printf ( "\nEnter a sentence not more than 80 chars long:\n" ) ;
    gets ( str ) ;

    s = str ; /* Base address of the string */

```

```
p = str2 ; /* Base address of new string */
while ( *s )
{
    q = s ;
    if ( *s == 't' || *s == 'T' )
    {
        s++ ;
        if ( *s == 'h' )
        {
            s++ ;
            if ( *s == 'e' )
            ;
            else
            {
                for ( i = 0; i <= 2 ; i++ )
                    *p++ = *q++ ;
            }
        }
        else
        {
            *p++ = *q++ ;
            s-- ;
        }
    }
    else
        *p++ = *s ;
    s++ ;
}

*p = '\0' ;
printf ( "\n\nSentence after deleting all occurrences of 'the' is:\n" ) ;
puts ( str2 ) ;

return 0 ;
}
```

- (i) Write a program that takes a set of names of individuals and abbreviates the first, middle and other names except the last name by their first letter.

Program:

```
/* Convert a full name into initials & last name */
#include <stdio.h>

int main( )
{
    char str[ 30 ];
    char *p ;
    int count = 0, l ;

    printf ( "\nEnter name, middle name and surname:\n" );
    gets ( str );

    p = str ; /* Base address of the string */

    /* Count number of blank spaces */
    while ( *p )
    {
        if ( *p == ' ' )
            count++ ;
        p++ ;
    }
    p = str ;

    printf ( "\nThe name converted to initials is: " );
    while ( count )
    {
        printf ( "%c.", *p );
        while ( *p != ' ' )
            p++ ;
        p++ ;
        count-- ;
    }
```

```
    }

    printf ( "%s\n", p ) ;

    return 0 ;
}
```

- (j) Write a program to count the number of occurrences of any two vowels in succession in a line of text. For example, in the sentence

“Please read this application and give me gratuity”
such occurrences are ea, ea, ui.

Program:

```
/* Check for 2 vowels in succession */
# include <stdio.h>

int main( )
{
    char str[ 80 ] ;
    int count = 0 ;
    char *s = str ;

    printf ( "\nEnter the string:\n" ) ;
    gets ( str ) ;

    while ( *s )
    {
        if ( *s == 'a' || *s == 'e' || *s == 'i' || *s == 'o' || *s == 'u' )
        {
            s++ ;
            if ( *s == 'a' || *s == 'e' || *s == 'i' || *s == 'o' ||
                *s == 'u' )
                count ++ ;
        }
        s++ ;
    }
```

```

    }
    printf ( "Number of occurrences of two successive vowels: %d\n" ,
            count ) ;

    return 0 ;
}

```

- (k) Write a program that receives an integer (less than or equal to nine digits in length) and prints out the number in words. For example, if the number input is 12342, then the output should be Twelve Thousand Three Hundred Forty Two.

Program:

```

/* Convert number to words */
#include<stdio.h>

void convert ( long, char [ ] ) ;

char *one[ ] = {
    " ", " One", " Two", " Three", " Four", " Five",
    " Six", " Seven", " Eight", " Nine", " Ten",
    " Eleven", " Twelve", " Thirteen", " Fourteen",
    " Fifteen", " Sixteen", " Seventeen", " Eighteen",
    " Nineteen"
};

char *ten[ ] = {
    " ", " ", " ", " Twenty", " Thirty", " Forty", " Fifty",
    " Sixty", " Seventy", " Eighty", " Ninety"
};

int main( )
{
    long num ;

    printf ( "\nEnter any Number (max 9 digits): " ) ;

```

```

scanf ( "%ld", &num );

if ( num <= 0 )
    printf ( "No negative numbers please...\n" );
else
{
    convert ( ( num / 10000000 ), "Crore" );
    convert ( ( ( num / 100000 ) % 100 ), "Lakh" );
    convert ( ( ( num / 1000 ) % 100 ), "Thousand" );
    convert ( ( ( num / 100 ) % 10 ), "Hundred" );
    convert ( ( num % 100 ), " " );
}
}

void convert ( long n, char *s )
{
    if ( n > 19 )
        printf ( "%s %s ", ten[ n / 10 ], one[ n % 10 ] );
    else
        printf ( "%s ", one[ n ] );

    if ( n )
        printf ( "%s ", s );
}

```

- (l) Write a program that receives a 5-digit number and prints it out in large size as shown below:

```

#####  #####  #  #  #####
#      #  ##  #  #
#      #  #  #  #
#####  #  #  #  #####
#  #####  #  #  ####  #
#  #      #  #  #
#  #      #  #  #
#####  #####  ###  #  #####

```


Program:

```
// Banner.cpp : Defines the entry point for the console application.
//

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

#include <windows.h>
#include <conio.h>

void gotoxy ( short col, short row ) ;

int main()
{
    int digits[ ][ 8 ][ 5 ] = {
        {
            1,1,1,1,1,
            1,0,0,0,1,
            1,0,0,0,1,
            1,0,0,0,1,
            1,0,0,0,1,
            1,0,0,0,1,
            1,0,0,0,1,
            1,0,0,0,1,
            1,1,1,1,1
        },
        {
            0,0,1,0,0,
            0,1,1,0,0,
            0,0,1,0,0,
            0,0,1,0,0,
            0,0,1,0,0,
            0,0,1,0,0,
            0,0,1,0,0,
            0,0,1,0,0,
            0,1,1,1,0
        },
        {
            1,1,1,1,1,

```

```
0,0,0,0,1,
0,0,0,0,1,
0,0,0,0,1,
1,1,1,1,1,
1,0,0,0,0,
1,0,0,0,0,
1,1,1,1,1
},
{
1,1,1,1,1,
0,0,0,0,1,
0,0,0,0,1,
1,1,1,1,1,
0,0,0,0,1,
0,0,0,0,1,
0,0,0,0,1,
1,1,1,1,1
},
{
1,0,0,0,0,
1,0,0,0,0,
1,0,0,0,0,
1,0,1,0,0,
1,1,1,1,1,
0,0,1,0,0,
0,0,1,0,0,
0,0,1,0,0
},
{
1,1,1,1,1,
1,0,0,0,0,
1,0,0,0,0,
1,1,1,1,1,
0,0,0,0,1,
0,0,0,0,1,
0,0,0,0,1,
1,1,1,1,1
},
```

```
{
    1,1,1,1,1,
    1,0,0,0,0,
    1,0,0,0,0,
    1,1,1,1,1,
    1,0,0,0,1,
    1,0,0,0,1,
    1,0,0,0,1,
    1,1,1,1,1
```

```
},
{
    1,1,1,1,1,
    0,0,0,0,1,
    0,0,0,0,1,
    0,0,0,0,1,
    0,0,0,0,1,
    0,0,0,0,1,
    0,0,0,0,1,
    0,0,0,0,1
```

```
},
{
    1,1,1,1,1,
    1,0,0,0,1,
    1,0,0,0,1,
    1,1,1,1,1,
    1,0,0,0,1,
    1,0,0,0,1,
    1,0,0,0,1,
    1,1,1,1,1
```

```
},
{
    1,1,1,1,1,
    1,0,0,0,1,
    1,0,0,0,1,
    1,1,1,1,1,
    0,0,0,0,1,
    0,0,0,0,1,
    0,0,0,0,1,
```

```

                                1,1,1,1,1
                                }
                                };

char str[ 6 ];
int i, j, k, l, r, c ;

printf ( "\nEnter a 5 digit number: " );
scanf ( "%s", str );

if ( strlen ( str ) > 5 )
{
    printf ( "Your number has more than 5 digits\n" );
    return 1 ;
}

system ( "cls" );
i = 0 ;
while ( str[ i ] != '\0' )
{
    j = str[ i ] - 48 ;

    for ( r = 0, k = 0 ; r <= 7 ; k++, r++ )
    {
        for ( l = 0, c = i * 6 ; l <= 4 ; l++, c++ )
        {
            if ( digits[ j ][ k ][ l ] == 1 )
            {
                gotoxy ( c, r );
                printf ( "#" );
            }
        }
    }
    i++ ;
}
printf ( "\n" );

return 0;

```

```
}  
  
void gotoxy ( short col, short row )  
{  
    HANDLE hStdout = GetStdHandle ( STD_OUTPUT_HANDLE ) ;  
    COORD position = { col, row } ;  
    SetConsoleCursorPosition ( hStdout, position ) ;  
}
```

CHAPTER SEVENTEEN

Structures

[A] What will be the output of the following programs:

```
(a) #include <stdio.h>
    #include <string.h>
    int main( )
    {
        struct gospel
        {
            int num ;
            char mess1[50] ;
            char mess2[50] ;
        } m ;

        m.num = 1 ;
        strcpy ( m.mess1, "If all that you have is hammer" ) ;
        strcpy ( m.mess2, "Everything looks like a nail" ) ;

        /* assume that the structure is located at address 1004 */
        printf ( "%u %u %u\n", &m.num, m.mess1, m.mess2 ) ;
        return 0 ;
    }
```

Output:

Address of each structure element would be printed out

```
(b) #include <stdio.h>
#include <string.h>
int main( )
{
    struct part
    {
        char partname[50];
        int partnumber;
    };
    struct part p, *ptrp;

    ptrp = &p;
    strcpy ( p.partname, "CrankShaft" );
    p.partnumber = 102133;

    printf ( "%s %d\n", p.partname, p.partnumber );
    printf ( "%s %d\n", (*ptrp).partname, (*ptrp).partnumber );
    printf ( "%s %d\n", ptrp->partname, ptrp->partnumber );
    return 0;
}
```

Output:

```
CrankShaft 102133
CrankShaft 102133
CrankShaft 102133
```

```
(c) #include <stdio.h>
struct gospel
{
    int num;
    char mess1[50];
    char mess2[50];
} m1 = { 2, "If you are driven by success",
        "make sure that it is a quality drive"
};
int main( )
{
```

```
    struct gospel m2, m3 ;
    m2 = m1 ;
    m3 = m2 ;
    printf ( "%d %s %s\n", m1.num, m2.mess1, m3.mess2 ) ;
    return 0 ;
}
```

Output:

2 If you are driven by success make sure that it is a quality drive

[B] Point out the errors, if any, in the following programs:

```
(a) #include <stdio.h>
    #include <string.h>
    int main( )
    {
        struct employee
        {
            char name[ 25 ] ;
            int age ;
            float salary ;
        } ;
        struct employee e ;
        strcpy ( e.name, "Shailesh" ) ;
        age = 25 ;
        salary = 15500.00 ;
        printf ( "%s %d %f\n", e.name, age, salary ) ;
        return 0 ;
    }
```

Error. The definition of structure **employee** should be followed by a ; age cannot be accessed directly . Use e.age.

```
(b) #include <stdio.h>
    int main( )
    {
```



```

    struct
    {
        char bookname[ 25 ];
        float price ;
    };
    struct book b = { "Go Embedded!", 240.00 };
    printf ( "%s %f\n", b.bookname, b.price );
    return 0 ;
}

```

Error. Undefined structure **book**

```

(c) # include <stdio.h>
    struct virus
    {
        char signature[ 25 ];
        char status[ 20 ];
        int size ;
    } v[ 2 ] = {
        "Yankee Doodle", "Deadly", 1813,
        "Dark Avenger", "Killer", 1795
    };
    int main( )
    {
        int i ;
        for ( i = 0 ; i <=1 ; i++ )
            printf ( "%s %s\n", v.signature, v.status );
        return 0 ;
    }

```

Error. While printing signature and status, **v[i].signature** and **v[i].status** should be used.

```

(d) # include <stdio.h>
    struct s
    {
        char ch ;
        int i ;
    }

```

```
float a ;
};
void f ( struct s ) ;
void g ( struct s * ) ;

int main( )
{
    struct s var = { 'C', 100, 12.55 } ;
    f ( var ) ;
    g ( &var ) ;
    return 0 ;
}
void f ( struct s v )
{
    printf ( "%c %d %f\n", v -> ch, v -> i, v -> a ) ;
}
void g ( struct s *v )
{
    printf ( "%c %d %f\n", v.ch, v.i, v.a ) ;
}
```

Error. In function **f()** dot operator should be used to access structure elements, while in function **g()** -> operator should be used to access structure elements.

```
(e) #include <stdio.h>
struct s
{
    int i ;
    struct s *p ;
};
int main( )
{
    struct s var1, var2 ;

    var1.i = 100 ;
    var2.i = 200 ;
    var1.p = &var2 ;
```

```
    var2.p = &var1 ;  
    printf ( "%d %d\n", var1.p -> i, var2.p -> i ) ;  
    return 0 ;  
}
```

No Error.

[C] Answer the following:

- (a) Ten floats are to be stored in memory. What would you prefer, an array or a structure?

Answer:

An array

- (b) Given the statement,

```
maruti.engine.bolts = 25 ;
```

which of the following is True?

1. structure bolts is nested within structure engine
2. structure engine is nested within structure maruti
3. structure maruti is nested within structure engine
4. structure maruti is nested within structure bolts

Answer:

- (1) structure bolts is nested within structure engine

- (c) State True or False:

1. All structure elements are stored in contiguous memory locations.

Answer: True

2. An array should be used to store dissimilar elements, and a structure to store similar elements.

Answer: False

3. In an array of structures, not only are all structures stored in contiguous memory locations, but the elements of individual structures are also stored in contiguous locations.

Answer: True

(d) struct time

```
{
    int hours ;
    int minutes ;
    int seconds ;
} t ;
struct time *pt ;
pt = &t ;
```

With reference to above declarations which of the following refers to **seconds** correctly:

1. pt.seconds
2. (*pt).seconds
3. time.seconds
4. pt -> seconds

Answer:

4. tt -> seconds

(e) Match the following with reference to the following program segment:

```
struct
{
```

```

int x, y;
} s[] = { 10, 20, 15, 25, 8, 75, 6, 2 };
int *i;
i = s;

```

- | | |
|--|--------|
| 1. $*(i + 3)$ | a. 85 |
| 2. $s[i[7]].x$ | b. 2 |
| 3. $s[(s + 2) \rightarrow y / 3[I]].y$ | c. 6 |
| 4. $i[i[1] - i[2]]$ | d. 7 |
| 5. $i[s[3].y]$ | e. 16 |
| 6. $(s + 1) \rightarrow x + 5$ | f. 15 |
| 7. $*(1 + i) ** (i + 4) / *i$ | g. 25 |
| 8. $s[i[0] - i[4]].y + 10$ | h. 8 |
| 9. $(*(s + *(i + 1) / *i)).x + 2$ | i. 1 |
| 10. $++i[i[6]]$ | j. 100 |
| | k. 10 |
| | l. 20 |

Answer:

- | | |
|--|-------|
| 1. $*(i + 3)$ | g. 25 |
| 2. $S[i[7]].x$ | h. 8 |
| 3. $S[(s + 2) \rightarrow y / 3[I]].y$ | b. 2 |
| 4. $i[i[1] - i[2]]$ | i. 75 |
| 5. $i[s[3].y]$ | f. 15 |
| 6. $(s + 1) \rightarrow x + 5$ | l. 20 |
| 7. $(1 + i) * (i + 4) / *i$ | e. 16 |
| 8. $S[i[0] - i[4]].y + 10$ | a. 85 |
| 9. $(*(s + *(i + 1) / *i)).x + 2$ | k. 10 |
| 10. $++i[i[6]]$ | d. 7 |

[D] Attempt the following:

(a) Create a structure to specify data on students given below:

Roll number, Name, Department, Course, Year of joining

Assume that there are not more than 450 students in the college.

- (a) Write a function to print names of all students who joined in a particular year.
- (b) Write a function to print the data of a student whose roll number is received by the function.

Program:

```
/* create structure to hold student data */
#include <stdio.h>

struct stud
{
    int r_n; /* Roll Number */
    char name[ 20 ]; /* Name */
    char dep[ 15 ]; /* Department */
    char course[ 10 ]; /* Course */
    int y_o_j; /* Year Of Joining */
};

struct stud s[ 450 ]; /* array of structure */

void set_student_data( ) ;
void display( ) ;
void name_acc_year ( int ) ;
int data_acc_rollno ( int ) ;

int main( )
{
    int i, r ;
    int y ;

    printf ( "\nEnter the data for each Student:\n\n " ) ;

    /* Initialize the values for the students structure */
    set_student_data( ) ;
```

```
/* Display all the elements of the student structure */
display( ) ;

/* Search data on year of Joining */
printf ( "\nEnter the Year of Joining of the Student " ) ;
scanf ( "%d", &y ) ;

name_acc_year ( y ) ; /* year of joining passed to function */

/* Search data based on roll number */
printf ( "\nEnter the Roll Number of the Student" ) ;
scanf ( "%d", &r ) ;

data_acc_rollno ( r ) ; /* roll number passed to function */
return 0 ;
}

void set_student_data( ) /* Enter student data */
{
    int i ;
    for ( i = 0 ; i < 450 ; i++ )
    {
        fflush ( stdin ) ; /* Flush the input buffer */
        printf ( "\nEnter the Roll NUmber of the student\n" ) ;
        scanf ( "%d", &s[ i ].r_n ) ;
        fflush ( stdin ) ;
        printf ( "Enter the name of the student\n" ) ;
        scanf ( "%s", s[ i ].name ) ;
        fflush ( stdin ) ;
        printf ( "Enter the name of the Department\n" ) ;
        scanf ( "%s", s[ i ].dep ) ;
        fflush ( stdin ) ;
        printf ( "Enter the name of the Course\n" ) ;
        scanf ( "%s", s[ i ].course ) ;
        fflush ( stdin ) ;
        printf ( "Enter the Year of Joining of the student\n" ) ;
        scanf ( "%d", &s[ i ].y_o_j ) ;
    }
}
```

```
}

/* function to display data */
void display( )
{
    int i ;
    for ( i = 0 ; i < 450 ; i++ )
    {
        printf ( "\n\tRoll Number of student %d = %d \n", i+1 ,
                s[ i ].r_n ) ;
        printf ( "\n\tName of student %d = %s \n", i+1, s[ i ].name ) ;
        printf ( "\n\tName of the Department = %s \n", s[ i ].dep ) ;
        printf ( "\n\tName of the Course = %s \n", s[ i ].course ) ;
        printf ( "\n\tYear of Joining of student %d = %d \n\n", i+1 ,
                s[ i ].y_o_j ) ;
    }
}

/* function to get name based on year of joining */
void name_acc_year ( int y )
{
    int i, j = 0 ;

    for ( i = 0 ; i < 450 ; i++ )
    {
        if ( y == s[ i ].y_o_j )
        {
            printf ( "%s joined in the year %d\n", s[ i ].name,
                    s[ i ].y_o_j ) ;
            j = 1 ;
        }
    }
    if ( j == 0 )
        printf ( "\nNo student joined in the year %d", y ) ;
}

/* function to get student data based on roll number */
int data_acc_rollno ( int r )
```



```

{
    int i, j = 0 ;
    for ( i = 0 ; i < 450 ; i++ )
    {
        if ( s[ i ].r_n == r )
        {
            printf ( "\n\tRoll Number of student = %d \n", s[ i ].r_n ) ;
            printf ( "\n\tName of student = %s \n", s[ i ].name ) ;
            printf ( "\n\tName of the Department = %s \n", s[ i ].dep ) ;
            printf ( "\n\tName of the Course = %s \n", s[ i ].course ) ;
            printf ( "\n\tYear of Joining of student = %d \n\n",
                    s[ i ].y_o_j ) ;

            j = 1 ;
        }
    }
    if ( j == 0 )
        printf ( "\nNo such Roll Number present." ) ;
}

```

(b) Create a structure to specify data of customers in a bank. The data to be stored is: Account number, Name, Balance in account. Assume maximum of 200 customers in the bank.

(a) Write a function to print the Account number and name of each customer with balance below Rs. 100.

(b) If a customer requests for withdrawal or deposit, it is given in the form:

Acct. no, amount, code (1 for deposit, 0 for withdrawal)

Write a program to give a message, “The balance is insufficient for the specified withdrawal”, if on withdrawal the balance falls below Rs. 100.

Program:

```

/* Create structure of 200 customer's banks data */
#include <stdio.h>

```

```
/* function to link the floating point format*/
void fun( )
{
    float f, *ff = &f;
}

/* structure for customer */
struct customer
{
    int acc_no;
    char name[ 20 ];
    float bal_i_acc;
};
struct customer cust[ 200 ];

/* function prototypes */
void with_dep ( int ano, float amount );
void deposit ( int ano, float amount );
void withdrawal ( int ano, float amount );
void low_bal( );
void display( );
void set_cust_data( );

int main( )
{
    int i, ano, choice;
    float amount;

    /* initialise Customer record */
    set_cust_data( );
    /* display record of all the customers */
    display( );

    /* print name and account number of the customer
       whose balance is less then 100 */
    low_bal( );
    /* withdraw or deposit the amount in the account
```

```
        Number of the specified customer */

printf ( "\nEnter the account number and the amount to be
        deposited/withdrawn: " );
scanf ( "%d%f", &ano, &amount );
with_dep ( ano, amount );

/*display all the records of the customers*/
display( );
return 0 ;
}

void with_dep ( int ano, float amount )
{
    int choice ;

    printf ( "Enter 1 for Deposit\t\tEnter 0 for Withdrawal" );
    scanf ( "%d", &choice );
    switch ( choice )
    {
        case 1 :
            deposit ( ano, amount );
            break ;
        case 0 :
            withdrawal ( ano, amount );
            break ;
        default :
            printf ( "You entered wrong choice\n" );
    }
}

void deposit ( int ano, float amount )
{
    int i, j = 0 ;

    for ( i = 0 ; i < 200 ; i++ )
    {
        if ( cust[ i ].acc_no == ano )
```

```
        {
            cust[ i ].bal_i_acc += amount ;
            j = 1 ;
        }
    }
    if ( j == 0 )
        printf ( "\n\tWrong Account Number\n" ) ;
}

void withdrawal ( int ano, float amount )
{
    int i, j = 0 ;

    for ( i = 0 ; i < 200 ; i++ )
    {
        if ( cust[ i ].acc_no == ano )
        {
            j = 1 ;
            if ( cust[ i ].bal_i_acc < 100 )
            {
                printf ( "\n\t\tThe Balance is insufficient for the
                    specified Withdrawal\n" ) ;
            }
            else
                if ( cust[ i ].bal_i_acc - 100 >= amount )
                    cust[ i ].bal_i_acc -= amount ;
                else
                    printf ( "\n\t\twithdrawal amount should be less than
                        or equal to %f Rs.\n", cust[ i ].bal_i_acc - 100 ) ;
            }
        }
    }
    if ( j == 0 )
        printf ( "\n\tWrong Account Number\n" ) ;
}

void low_bal( )
{
    int i, j = 0 ;
```

```
printf ( "\n\nName and Account number of the customers \nwhose
        balance is less than 100\n" );
for ( i = 0 ; i < 200 ; i++ )
{
    if ( cust[ i ].bal_i_acc < 100 )
    {
        j = 1 ;
        printf ( "\tCustomer Number = %d\n", i+1 ) ;
        printf ( "\t\tAccount Number of Customer = %d\n",
                cust[ i ].acc_no ) ;
        printf ( "\t\tName of Customer = %s\n", cust[ i ].name ) ;
    }
}
if ( j == 0 )
    printf ( "\n\tEvery Customer has more than minimum balance
            amount\n" );
}

void display( )
{
    int i ;

    for ( i = 0 ; i < 200 ; i++ )
    {
        printf ( "\n\n\tCustomer Number = %d\n", i+1 ) ;
        printf ( "\tAccount Number of Customer = %d\n",
                cust[ i ].acc_no ) ;
        printf ( "\tName of Customer = %s\n", cust[ i ].name ) ;
        printf ( "\tBalance Amount of Customer = %.3f\n",
                cust[ i ].bal_i_acc ) ;
    }
}

void set_cust_data( )
{
    int i ;
```

```
for ( i = 0 ; i < 200 ; i++ )
{
    printf ( "\n\nEnter the Account number of the Customer\n\t" ) ;
    scanf ( "%d", &cust[ i ].acc_no ) ;

    fflush ( stdin ) ;
    printf ( "\nEnter the name of the Customer\n\t" ) ;
    scanf ( "%s", cust[ i ].name ) ;

    fflush ( stdin ) ;
    printf ( "\nEnter the balance amount in the Customer
            account\n\t" ) ;
    scanf ( "%f", &cust[ i ].bal_i_acc ) ;
}
}
```

- (c) An automobile company has serial number for engine parts starting from AA0 to FF9. The other characteristics of parts are Year of manufacture, material and quantity manufactured.
- (a) Specify a structure to store information corresponding to a part.
 - (b) Write a program to retrieve information on parts with serial numbers between BB1 and CC6.

Program:

```
/* Create structure to store engine parts data */
#include <stdio.h>

struct automobile
{
    int s_no ;
    int year_o_manu ;
    char material[ 20 ] ;
    int quantity ;
};

struct automobile part[ 2 ] ;
```

```
void retrieve( ) ;
void display( ) ;
void set_auto_data( ) ;

int main( )
{
    int i ;

    /* set the values for the records*/
    set_auto_data( ) ;

    /* list all the records*/
    display( ) ;

    /* retrieve info on parts with serial number between BB1 & CC6*/
    retrieve( ) ;
    return 0 ;
}

void retrieve( )
{
    int i, j = 0 ;

    printf ( "\nList of parts between BB1 & CC6:" ) ;
    for ( i = 0 ; i < 2 ; i++ )
    {
        if ( ( part[ i ].s_no >= 0xbb1 ) && ( part[ i ].s_no <= 0xcc6 ) )
        {
            j = 1 ;
            printf ( "\n\n\tPart Number = %d", i ) ;
            printf ( "\nSerial Number = %x", part[ i ].s_no ) ;
            printf ( "\nYear of manufacturing = %d",
                    part[ i ].year_o_manu ) ;
            printf ( "\nMaterial used : %s", part[ i ].material ) ;
            printf ( "\nManufacture Quantity = %d", part[ i ].quantity ) ;
        }
    }
}
```

```
        if ( j == 0 )
            printf ( "\nNo such record present" ) ;
    }

    void display( )
    {
        int i ;

        for ( i = 0 ; i < 2 ; i++ )
        {
            printf ( "\n\n\tPart Number = %d", i ) ;
            printf ( "\nSerial Number = %x", part[ i ].s_no ) ;
            printf ( "\nYear of manufacturing = %d", part[ i ].year_o_manu ) ;
            printf ( "\nMaterial used : %s", part[ i ].material ) ;
            printf ( "\nManufacture Quantity = %d", part[ i ].quantity ) ;
        }
    }

    void set_auto_data( )
    {
        int i ;
        for ( i = 0 ; i < 2 ; i++ )
        {
            while ( 1 )
            {
                printf ( "\nEnter the serial Number of the part" ) ;
                printf ( "\nNumber must be between AA0 and FF9 " ) ;
                scanf ( "%x", &part[ i ].s_no ) ;
                if ( part[ i ].s_no >= 0xAA0 && part[ i ].s_no <= 0xFF9 )
                    break ;
            }
            printf ( "\nEnter the Year of manufacturing of the part" ) ;
            scanf ( "%d", &part[ i ].year_o_manu ) ;

            printf ( "\nEnter the material of the part" ) ;
            scanf ( "%s", &part[ i ].material ) ;
            fflush ( stdin ) ;
        }
    }
}
```



```

        printf ( "\nEnter the quantity of the part" );
        scanf ( "%d", &part[ i ].quantity );
    }
}

```

- (d) A record contains name of cricketer, his age, number of test matches that he has played and the average runs that he has scored in each test match. Create an array of structures to hold records of 20 such cricketers and then write a program to read these records and arrange them in ascending order by average runs. Use the **qsort()** standard library function.

Program:

```

/* Create array of structures, sort and display */
#include <malloc.h>
#include <stdio.h>
#include <stdlib.h>

void fun( );
int sort_function ( const void *, const void * );
void sortbyavg( );
void display( );
void setdata( );

/* Function to link the floating point formats */
void fun( )
{
    float f, *ff = &f;
    return f;
}

struct cric_player
{
    char name[ 20 ];
    int age;
    int notest;
}

```

```
float avgrun ;
};
struct cric_player cp[ 3 ] ;

int main( )
{
    /* set the values of the structure elements */
    setdata( ) ;

    /* display all the entries present in the structure */
    printf ( "\nData as entered : \n" ) ;
    display( ) ;

    /* sort the array of structures */
    sortbyavg( ) ;
    printf ( "\nData sorted on Average Runs :\n" ) ;
    display( ) ;

    return 0 ;
}

/* Function used for sorting the array of structures */
void sortbyavg( )
{
    int i, j ;
    struct cric_player t ;
    qsort ( ( struct cric_player * ) cp, 3, sizeof ( cp[ 0 ] ), sort_function ) ;
}

int sort_function ( const void *f, const void *ff )
{
    return ( ( ( struct cric_player * ) f ) -> avgrun - ( ( struct cric_player * )
        ff ) -> avgrun ) ;
}

/* Function to display all the entries present in the structure */
void display( )
{
```

```
int i ;

for ( i = 0 ; i < 3 ; i++ )
{
    printf ( "\n\n\tName : %s", cp[ i ].name ) ;
    printf ( "\n\tAge : %d", cp[ i ].age ) ;
    printf ( "\n\tNo of tests : %d", cp[ i ].notest ) ;
    printf ( "\n\tAverage : %f", cp[ i ].avgrun ) ;
}

/* Function to set the values of the structure */
void setdata( )
{
    int i ;

    for ( i = 0 ; i < 3 ; i++ )
    {
        printf ( "\nEnter the name:" ) ;
        scanf ( "%s", &cp[ i ].name ) ;
        fflush ( stdin ) ;

        printf ( "\nEnter the age:" ) ;
        scanf ( "%d", &cp[ i ].age ) ;
        fflush ( stdin ) ;

        printf ( "\nEnter the total number of test matches played:" ) ;
        scanf ( "%d", &cp[ i ].notest ) ;
        fflush ( stdin ) ;

        printf ( "\nEnter the avgerage number of runs scored in all the
                matches:\n\t" ) ;
        scanf ( "%f", &cp[ i ].avgrun ) ;
        fflush ( stdin ) ;
    }
}
```

- (e) There is a structure called **employee** that holds information like employee code, name and date of joining. Write a program to create an array of structures and enter some data into it. Then ask the user to enter current date. Display the names of those employees whose tenure is greater than equal to 3 years.

Program:

```
/* To display the names of those employees whose tenure is greater
than equal to 3 years */
#include <stdio.h>

#define NOOFEMP 5

struct date
{
    int day, month, year ;
};

int check_date ( struct date *dt );

int main( )
{
    struct employee
    {
        int code ;
        char emp_name [ 20 ] ;
        struct date doj ;
    };

    struct employee emp [ NOOFEMP ] ;
    int i, chkdt ;
    struct date curr ;

    printf ( "\nEnter current date: " ) ;
    chkdt = check_date ( &curr ) ;
    if ( chkdt == 0 )
```

```
{
    printf ( "\nImproper date entered" );
    exit ( 0 );
}

printf ( "\nEnter the information for %d employees : ", NOOFEMP );

for ( i = 0 ; i < NOOFEMP ; i++ )
{
    fflush ( stdin );
    printf ( "\nEmp %d : \nCode : ", i );
    scanf ( "%d", &emp[ i ].code );

    printf ( "\nName : " );
    scanf ( "%s", emp[ i ].emp_name );

    printf ( "\nDate of Joining (dd-mm-yyyy): " );
    chkdt = check_date ( &emp[ i ].doj );

    if ( chkdt == 0 )
    {
        printf ( "\nImproper date entered" );
        exit ( 0 );
    }
}

/* print names of employees whose tenure is 3 years or more */
printf ( "\nEmployees whose tenure is 3 years or more: " );

for ( i = 0 ; i < NOOFEMP ; i++ )
{
    if ( curr.year > emp[ i ].doj.year + 3 )
    {
        printf ( "\n%s", emp[ i ].emp_name );
        break ;
    }
    else
    {

```

```

        if ( curr.year == emp[ i ].doj.year + 3 )
        {
            if ( curr.month > emp[ i ].doj.month )
            {
                printf ( "\n%s", emp[ i ].emp_name ) ;
            }
            else
            {
                if ( ( curr.month == emp[ i ].doj.month ) &&
                    ( curr.day >= emp[ i ].doj.day ) )
                    printf ( "\n%s", emp[ i ].emp_name ) ;
            }
        }
    }
}

return 0 ;
}

/* Function to check the date entered */
int check_date ( struct date *dt )
{
    printf ( "\nEnter date (dd): " ) ;
    scanf ( "%d", &dt -> day ) ;

    printf ( "\nEnter month (mm): " ) ;
    scanf ( "%d", &dt -> month ) ;

    printf ( "\nEnter year (yyyy): " ) ;
    scanf ( "%d", &dt -> year ) ;

    if ( ( dt -> day > 31 || dt -> day < 0 ) ||
        ( dt -> month > 12 || dt -> month < 0 ) ||
        ( dt -> year > 9999 || dt -> year < 1000 ) )
    {
        return ( 0 ) ;
    }
    else

```

```
        return ( 1 );  
    }
```

- (f) Create a structure called **library** to hold accession number, title of the book, author name, price of the book, and flag indicating whether book is issued or not. Write a menu-driven program that implements the working of a library. The menu options should be:

1. Add book information
2. Display book information
3. List all books of given author
4. List the title of specified book
5. List the count of books in the library
6. List the books in the order of accession number
7. Exit

Program:

```
/* A menu driven program */  
#include <stdio.h>  
  
void add_book( ) ;  
void disp_book( ) ;  
void disp_book_auth ( int aut_ano ) ;  
void sortbyano( ) ;  
int sort_function ( const void *f, const void *ff ) ;  
void linkfloat( ) ;  
  
struct library  
{  
    char book_title [ 20 ] ;  
    char author_name [ 20 ] ;  
    int accno ;  
    float price ;  
    int flag ;  
};
```

```
int count ;
struct library book [ 10 ] ;

int main( )
{
    int choice ;

    while ( 1 )
    {
        printf ( "\n1. Add book information" ) ;
        printf ( "\n2. Display book information" ) ;
        printf ( "\n3. List all books of given author" ) ;
        printf ( "\n4. List the title of specified book" ) ;
        printf ( "\n5. List the count of books in the library" ) ;
        printf ( "\n6. List the books in the order of accession number" ) ;

        printf ( "\n7. Exit" ) ;
        printf ( "\nYour choice? " ) ;
        scanf ( "%d", &choice ) ;

        switch ( choice )
        {
            case 1 :
                /* add book information */
                add_book( ) ;
                break ;
            case 2 :
                /* display book information */
                disp_book( ) ;
                break ;
            case 3 :
                /* list all books of given author */
                disp_book_auth ( 0 ) ;
                break ;
            case 4 :
                /* list the title of specified book */
                disp_book_auth ( 1 ) ;
                break ;
```



```
        case 5 :
            /* list the count of books in the library */
            printf ( "\nThe total number of books in the library is
                    %d", count ) ;
            break ;
        case 6 :
            /* list the books in the order of accession number */
            sortbyano( ) ;
            break ;
        case 7 :
            exit ( 0 ) ;
    }
}
return 0 ;
}

/* Function to add a new book */
void add_book( )
{
    if ( count == 9 )
    {
        printf ( "\nNo more space" ) ;
        return ;
    }

    printf ( "\nEnter the details of the book" ) ;
    printf ( "\nName of the book: " ) ;
    scanf ( "%s", book[ count ].book_title ) ;

    printf ( "\nName of the author: " ) ;
    scanf ( "%s", book[ count ].author_name ) ;

    printf ( "\nAccession number of the book: " ) ;
    scanf ( "%d", &book[ count ].accno ) ;

    printf ( "\nPrice of the book: " ) ;
    scanf ( "%f", &book[ count ].price ) ;
    printf ( "\nIssued / Not Issued ( 0/1 ) : " ) ;
```

```
scanf ( "%d", &book[ count ].flag );

if ( ( book[ count ].flag != 0 ) && ( book[ count ].flag != 1 ) )
{
    printf ( "\nImproper Status" );
    return ;
}
count++ ;
printf ( "\nBook details entered" );
}

/* function to display books' info */
void disp_book( )
{
    int i ;

    printf ( "\nDetails of %d books in the library: ", count ) ;
    for ( i = 0 ; i < count ; i++ )
    {
        printf ( "\nName of the book: %s", book[ i ].book_title ) ;
        printf ( "\nName of the author: %s", book[ i ].author_name ) ;
        printf ( "\nAccession number of the book: %d", book[ i ].accno ) ;
        printf ( "\nPrice of the book: %f", book[ i ].price ) ;
        printf ( "\nStatus of the book: " ) ;
        book[ i ].flag == 0 ? printf ( "Issued" ) : printf ( "Available" ) ;
        printf ( "\n\n" );
    }
}

/* Function to display books' info for a given author */
void disp_book_auth ( int aut_ano)
{
    char *nm [ 20 ] ;
    int accno;
    int i = 0 ;
    int dec = 0 ;

    /* check if author name is given or accession no is given */
```

```
if ( aut_ano == 0 )
{
    printf ( "\nEnter the name of the author : " );
    scanf ( "%s", nm );
    printf ( "\nDetails of the books by the author %s in the library: ",
            nm );
}
else
{
    printf ( "\nEnter the accession number of the book : " );
    scanf ( "%d", &accno );
    printf ( "\nDetails of the books with accession no %d: ", accno );
}

for ( i = 0 ; i < count ; i++ )
{
    if ( ( strcmp ( nm, book[ i ].author_name ) == 0 ) &&
        ( aut_ano == 0 ) )
        dec++ ;
    else
    {
        if ( aut_ano == 1 )
        {
            if ( book[ i ].accno == accno )
                dec++ ;
            else
                continue ;
        }
        else
            break ;
    }
    printf ( "\nName of the book: %s", book[ i ].book_title );
    printf ( "\nName of the author: %s", book[ i ].author_name );
    printf ( "\nAccession number of book: %d", book[ i ].accno );
    printf ( "\nPrice of the book: %f", book[ i ].price );
    printf ( "\nStatus of the book: " );
    book[ i ].flag == 0 ? printf ( "Issued" ) : printf ( "Available" );
    printf ( "\n\n" );
}
```

```

    }
    if ( dec == 0 )
        printf ( "\nNo such book" );
}

/* Function to sot books by accession number */
void sortbyano( )
{
    qsort ( ( struct library * ) book, count, sizeof ( book[ 0 ] ),
            sort_function );
    printf ( "\nAfter sorting by accession number " );
    disp_book ( );
}

int sort_function ( const void *f, const void *ff )
{
    return ( ( ( struct library * ) f ) -> accno - ( ( struct library * )
            ff ) -> accno );
}

void linkfloat( )
{
    float a = 0, *b ;
    b = &a ;
    a = *b ;
}

```

- (g) Write a function that compares two given dates. To store a date use a structure that contains three members namely day, month and year. If the dates are equal the function should return 0, otherwise it should return 1.

Program:

```

/* Create Date structure and compare the dates */
# include <stdio.h>

```

```
struct date
{
    int day, month, year ;
};

int check_date ( struct date *dt ) ;

int main( )
{
    int chkd ;
    struct date d1, d2 ;

    /* input the dates to be compared */
    printf ( "\nEnter the dates to be compared: " ) ;
    chkd = check_date ( &d1 ) ;

    if ( chkd == 0 )
        exit ( 0 ) ;

    fflush ( stdin ) ;

    chkd = check_date ( &d2 ) ;

    if ( chkd == 0 )
        exit ( 0 ) ;

    /*Compare the two structures*/
    if ( ( d1.day == d2.day ) && ( d1.month == d2.month )
        && ( d1.year == d2.year ) )
        printf ( "\nDates are Equal" ) ;
    else
        printf ( "\nDates are Unequal" ) ;
    return 0 ;
}

/* Function to check the date entered */
int check_date ( struct date *dt )
{
```

```

printf ( "\nEnter date (dd): " );
scanf ( "%d", &dt -> day );

printf ( "\nEnter month (mm): " );
scanf ( "%d", &dt -> month );

printf ( "\nEnter year (yyyy): " );
scanf ( "%d", &dt -> year );

if ( ( dt -> day > 31 || dt -> day < 0 ) ||
      ( dt -> month > 12 || dt -> month < 0 ) ||
      ( dt -> year > 9999 || dt -> year < 1000 ) )
{
    printf ( "\nImproper date entered" );
    return ( 0 );
}
else
    return ( 1 );
}

```

- (h) Linked list is a very common data structure that is often used to store similar data in memory. The individual elements of a linked list are stored “somewhere” in memory. The order of the elements is maintained by explicit links between them. Thus, a linked list is a collection of elements called nodes, each of which stores two item of information—an element of the list, and a link, i.e., a pointer or an address that indicates explicitly the location of the node containing the successor of this list element.

Write a program to build a linked list by adding new nodes at the beginning, at the end or in the middle of the linked list. Also write a function **display()** which displays all the nodes present in the linked list.

Program:

```
/* Build a Linked List */
```

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

/* structure definition */
struct linklist
{
    int item ;
    struct linklist *link ;
};

struct linklist *p ;

void add_item_at_loca ( int item, int loca ) ;
void add_end ( int item ) ;
void display( ) ;
void add ( int item ) ;

int main( )
{
    p = NULL ; /* last node link is always NULL */

    /* add items at beginning of linked list */
    add ( 10 ) ;
    add ( 20 ) ;
    add ( 30 ) ;
    add ( 40 ) ;
    printf ( "Items added at the begining of the list:\n" ) ;

    /* display all the items in the linked list */
    display( ) ;
    /* add item at the end of the linked list */
    printf ( "\n\nItem added at the end of list:\n" ) ;
    add_end ( 50 ) ;
    display( ) ;

    /* add item at a given location in linked list */
    printf ( "\n\nItem added in the middle of the list:\n" ) ;
    add_item_at_loca ( 60, 4 ) ;
    display( ) ;
```

```
    return 0 ;
}

void add_item_at_loca ( int item, int loca )
{
    struct linklist *q = ( struct linklist * ) malloc ( sizeof ( struct linklist ) ) ;
    struct linklist *r, *w = p ;
    int i = 1 ;

    q -> item = item ;
    q -> link = NULL ;
    if ( p == NULL )
        p = q ;
    else
    {
        while ( ( w->link != NULL ) && ( i != loca ) )
        {
            i++ ;
            w = w -> link ;
        }
        if ( i == loca )
        {
            r = w -> link ;
            w -> link = q ;
            q -> link = r ;
        }
        else
            w -> link = q ;
    }
}

void add_end ( int item )
{
    struct linklist *q = ( struct linklist * ) malloc ( sizeof ( struct linklist ) ) ;
    struct linklist *w = p ;

    q -> item = item ;
```



```
q -> link = NULL ;
if ( p == NULL )
    p = q ;
else
{
    while ( w -> link != NULL )
        w = w -> link ;
    w -> link = q ;
}
}

void display( )
{
    struct linklist *q = p ;
    int i = 0 ;

    while ( q != NULL )
    {
        i++ ;
        printf ( "\nitem number %d = %d ", i , q->item ) ;
        q = q -> link ;
    }
}

void add ( int item )
{
    struct linklist *q = ( struct linklist * ) malloc ( sizeof ( struct linklist ) ) ;

    q -> item = item ;
    q -> link = NULL ;
    if ( p == NULL )
        p = q ;
    else
    {
        q -> link = p ;
        p = q ;
    }
}
```

- (i) A stack is a data structure in which addition of new element or deletion of existing element always takes place at the same end known as 'top' of stack. Write a program to implement a stack using a linked list.

Program:

```
/* Implementation of stack using a linked list */
#include <malloc.h>
#include <stdio.h>

struct node
{
    int data ;
    struct node *link ;
};

void push ( struct node **s, int item ) ;
void displaystack ( struct node *q ) ;
int pop ( struct node **s ) ;
int count ( struct node * q ) ;

int main( )
{
    struct node *top ;
    int t, i, item ;

    top = NULL ;

    /* insert items in the stack */
    push ( &top, 45 ) ;
    push ( &top, 28 ) ;
    push ( &top, 63 ) ;
    push ( &top, 55 ) ;

    /* display items on the stack */
    displaystack ( top ) ;
```

```
t = count ( top ) ;
printf ( "\nTotal items = %d\n" , t ) ;

/* remove an item from stack */
printf ( "\nPopped : " ) ;
item = pop ( &top ) ;
printf ( "%d\n" , item ) ;

displaystack ( top ) ;
t = count ( top ) ;
printf ( "\nTotal items = %d" , t ) ;
return 0 ;
}

/* Function to add an item to stack */
void push ( struct node **s, int item )
{
    struct node *q ;

    q = ( struct node * ) malloc ( sizeof ( struct node ) ) ;
    q -> data = item ;
    q -> link = *s ;
    *s = q ;
}

/* Function to remove an item from stack */
int pop ( struct node **s )
{
    int item ;
    struct node *q ;
    if ( *s == NULL )
        printf ( "Stack is empty" ) ;
    else
    {
        q = *s ;
        item = q -> data ;
        *s = q -> link ;
        free ( q ) ;
    }
}
```

```
        return ( item ) ;
    }
}

/* Function to display contents of stack */
void displaystack ( struct node *q )
{
    while ( q != NULL )
    {
        printf ( "\t%2d ", q -> data ) ;
        q = q -> link ;
    }
}

/* Function to count items in the stack */
int count ( struct node * q )
{
    int c = 0 ;

    while ( q != NULL )
    {
        q = q -> link ;
        c++ ;
    }
    return c ;
}
```

- (j) In a data structure called queue the addition of new element takes place at the end (called ‘rear’ of queue) whereas deletion takes place at the other end (called ‘front’ of queue). Write a program to implement a queue using a linked list.

Program:

```
/* Implementation of a queue using linked list */
# include <stdio.h>
# include <malloc.h>
```

```
struct queue
{
    int item ;
    struct queue *link ;
};
struct queue *rear, *front ;
void add ( int item ) ;
int del_queue( ) ;
void display( ) ;
int count( ) ;

int main( )
{
    int item ;
    rear = front = NULL ;

    /* add an item to the queue */
    add ( 10 ) ;
    add ( 20 ) ;
    add ( 30 ) ;
    add ( 40 ) ;
    add ( 50 ) ;
    add ( 60 ) ;

    /* display all elements in the queue */
    display( ) ;
    printf ( "\nTotal number of elements present is : %d ", count( ) ) ;

    /* delete an element from the queue */
    item = del_queue( ) ;
    printf ( "\nDeleted Item = %d\n", item ) ;
    display( ) ;
    printf ( "\nTotal number of elements present is : %d ", count( ) ) ;

    item = del_queue( ) ;
    printf ( "\nDeleted Item = %d\n", item ) ;
    display( ) ;
    printf ( "\nTotal number of elements present is : %d ", count( ) ) ;
```

```
    item = del_queue( );
    printf ( "\nDeleted Item = %d\n", item );
    display( );
    printf ( "\nTotal number of elements present is : %d ", count( ) );
    return 0 ;
}

/* Function to add an item to the queue */
void add ( int item )
{
    struct queue *q = ( struct queue * ) malloc ( sizeof ( struct queue ) );
    q -> item = item ;
    q -> link = NULL ;
    if ( rear == NULL )
    {
        rear = q ;
        front = q ;
    }
    else
    {
        q -> link = rear ;
        rear = q ;
    }
}

/* Function to delete an element from the queue */
int del_queue( )
{
    int item ;

    struct queue *q = rear ;
    if ( front == NULL )
    {
        printf ( "\n\n\t\tQueue is empty" );
        return -1;
    }
    else
```

```
{
    if ( front == rear )
    {
        item = q -> item ;
        front = rear = NULL ;
        free( q ) ;
    }
    else
    {
        while( q -> link -> link != NULL )
            q = q -> link ;
        item = q -> link -> item ;
        free( q -> link ) ;
        front = q ;
        q -> link = NULL ;
    }
}
return item ;
}

/* Function to display all the elements in the queue */
void display( )
{
    struct queue *q = rear ;

    while ( q != NULL )
    {
        printf ( "\n%d", q -> item ) ;
        q = q -> link ;
    }
}

int count( )
{
    struct queue *q = rear ;
    int count = 0 ;

    while ( q != NULL )
```

```
    {  
        count ++ ;  
        q = q -> link ;  
    }  
    return count ;  
}
```

- (k) Write a program to implement an ascending order linked list. This means that any new element that is added to the linked list gets inserted at a place in the linked list such that its ascending order nature remains intact.

Program:

```
/* Implementation of an ascending order linked list */  
#include <stdio.h>  
  
struct node  
{  
    int data ;  
    struct node *link ;  
} *p ;  
  
void add ( int num ) ;  
void display( ) ;  
  
/* adds node to an ascending order linked list */  
void add ( struct node **q, int num )  
{  
    struct node *r, *temp = *q ;  
  
    r = malloc ( sizeof ( struct node ) ) ;  
    r -> data = num ;  
  
    /* if list is empty or if new node is to be  
       inserted before the first node */  
    if ( *q == NULL || ( *q -> data > num )
```



```

    {
        *q = r ;
        ( *q ) -> link = temp ;
    }
    else
    {
        /* traverse the entire linked list to search the position
        to insert the new node */
        while ( temp -> link != NULL )
        {
            if ( temp -> data <= num && ( temp -> link -> data > num ||
            temp -> link == NULL ) )
            {
                r -> link = temp -> link ;
                temp -> link = r ;
                return ;
            }
            /* go to the next node */
            temp = temp -> link ;
        }
        r -> link = NULL ;
        temp -> link = r ;
    }
}

/* Function to display contents of the linked list */
void display ( struct node *q )
{
    printf ( "\n" ) ;

    /* traverse the entire linked list */
    while ( q != NULL )
    {
        printf ( "%d ", q -> data ) ;
        q = q -> link ;
    }
    printf ( "\n" ) ;
}

```

```
int main( )
{
    struct node *l ;
    l = NULL ;

    add ( &l, 5 ) ;
    add ( &l, 1 ) ;
    add ( &l, 6 ) ;
    add ( &l, 2 ) ;
    add ( &l, 4 ) ;
    add ( &l, 7 ) ;

    printf ( "\nElements in the linked list in ascending order are: " ) ;
    display ( l ) ;

    return 0 ;
}
```

- (l) Write a program that receives wind speed as input and categorizes the hurricane as per the following table:

Wind Speed in miles / hour	Hurricane Category
74 – 95	I
96 – 110	II
111 – 130	III
131 – 155	IV
155	V

Program:

```
/* Determine hurricane category */
# include <stdio.h>
# include <string.h>

int main( )
{
```

```

struct hurricane
{
    int lowspeed ;
    int highspped ;
    char category[ 10 ] ;
};
struct hurricane h[ ] = {
    74, 95, "I",
    96, 110, "II",
    111, 130, "III",
    131, 155, "IV",
    155, 200, "V"
};

int ws, i ;

printf ( "\nEnter Wind speed: " ) ;
scanf ( "%d", &ws ) ;

for ( i = 0 ; i <= 4 ; i++ )
{
    if ( h[ i ].lowspeed <= ws && ws <= h[ i ].highspped )
        printf ( "Category of hurricane : %s\n", h[ i ].category ) ;
}

return 0 ;
}

```

- (m) There are five players from which the Most Valuable Player is to be chosen. Each player is to be judged by 3 judges, who would assign a rank to each player. The player whose sum of ranks is highest is chosen as MVP. Write a program to implement this scheme.

Program:

/ Determine the Most Valuable Player */*

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

int main( )
{
    struct player
    {
        char name[ 20 ] ;
        int rank[ 3 ] ;
        int total ;
    } ;

    struct player p[ ] = {
        "Sachin", { 0 }, 0,
        "Ponting", { 0 }, 0,
        "Rahul", { 0 }, 0,
        "Mahela", { 0 }, 0,
        "Gayle", { 0 }, 0,
    } ;

    char winner[ 20 ] ;
    int i, judge, big ;

    for ( judge = 0 ; judge <= 2 ; judge++ )
    {
        printf ( "Enter your ranks:\n" );
        for ( i = 0 ; i <= 4 ; i++ )
        {
            printf ( "%s: ", p[ i ].name ) ;
            scanf ( "%d", &p[ i ].rank[ judge ] ) ;
            p[ i ].total += p[ i ].rank[ judge ] ;
        }
    }

    big = p[ 0 ].total ;
    for ( i = 1 ; i <= 4 ; i++ )
    {
        if ( p[ i ].total > big )
```

```
        {
            big = p[ i ]. total ;
            strcpy ( winner, p[ i ].name ) ;
        }

    printf ( "Winner = %s Score = %d\n", winner, big ) ;

    return 0 ;
}
```

CHAPTER

EIGHTEEN

Console Input/Output

[A] What will be the output of the following programs:

(a)

```
#include <stdio.h>
#include <ctype.h>
int main( )
{
    char ch ;
    ch = getchar( ) ;
    if ( islower ( ch ) )
        putchar ( toupper ( ch ) ) ;
    else
        putchar ( tolower ( ch ) ) ;
    return 0 ;
}
```

<i>Input</i>	<i>Output:</i>
--------------	----------------

a	A
Z	z

(b)

```
#include <stdio.h>
int main( )
{
    int i = 2 ;
    float f = 2.5367 ;
    char str[ ] = "Life is like that" ;
```

```
printf ( "%4d\t%3.3ft%4s\n", i, f, str );  
return 0 ;  
}
```

Output:

2 2.537 Life is like that

```
(c) # include <stdio.h>  
int main( )  
{  
    printf ( "More often than \b\b not \rthe person who \  
            wins is the one who thinks he can!\n" );  
    return 0 ;  
}
```

Output:

the person who wins is the one who thinks he can!

```
(d) # include <conio.h>  
char p[ ] = "The sixth sick sheikh's sixth ship is sick";  
int main( )  
{  
    int i = 0 ;  
    while ( p[ i ] != '\0' )  
    {  
        putchar ( p[ i ] );  
        i++ ;  
    }  
    return 0 ;  
}
```

Output:

The sixth sick sheikh's sixth ship is sick

[B] Point out the errors, if any, in the following programs:

```
(a) #include <stdio.h>
int main( )
{
    int i ;
    char a[ ] = "Hello" ;
    while ( a != '\0' )
    {
        printf ( "%c", *a ) ;
        a++ ;
    }
    return 0 ;
}
```

Error. Lvalue required. Post-fix increment operator cannot be used with the name of the array.

```
(b) #include <stdio.h >
int main( )
{
    double dval ;
    scanf ( "%f", &dval ) ;
    printf ( "Double Value = %lf\n", dval ) ;
    return 0 ;
}
```

No Error. But the format specifier used for **double** in **scanf()** should be **lf** instead of **f**.

```
(c) #include <stdio.h>
int main( )
{
    int ival ;
    scanf ( "%d\n", &n ) ;
    printf ( "Integer Value = %d\n", ival ) ;
    return 0 ;
}
```


Error. Undefined symbol **n**.

```
(d) #include <stdio.h>
int main( )
{
    char *mess[ 5 ];
    int i;
    for ( i = 0 ; i < 5 ; i++ )
        scanf ( "%s", mess[ i ] );
    return 0 ;
}
```

Error. **i** undefined. Moreover when we use an array of pointers to strings the array should be initialised where it is declared.

```
(e) #include <stdio.h>
int main( )
{
    int dd, mm, yy ;
    printf ( "Enter day, month and year\n" ) ;
    scanf ( "%d%c%d%c%d", &dd, &mm, &yy ) ;
    printf ( "The date is: %d - %d - %d\n", dd, mm, yy ) ;
    return 0 ;
}
```

No Error. The asterisk (*) acts as a suppression character. Giving '*' in **scanf()** would skip the assignment of next scanned value to the specified address..

```
(f) #include <stdio.h>
int main( )
{
    char text ;
    sprintf ( text, "%4d\t%2.2f\n%s", 12, 3.452, "Merry Go Round" ) ;
    printf ( "%s\n", text ) ;
    return 0 ;
}
```

```
}
```

No error.

```
(g) #include <stdio.h>
int main( )
{
    char buffer[ 50 ];
    int no = 97;
    double val = 2.34174 ;
    char name[ 10 ] = "Shweta" ;

    sprintf ( buffer, "%d %lf %s", no, val, name ) ;
    printf ( "%s\n", buffer ) ;
    sscanf ( buffer, "%4d %2.2lf %s", &no, &val, name ) ;
    printf ( "%s\n", buffer ) ;
    printf ( "%d %lf %s\n", no, val, name ) ;
    return 0 ;
}
```

No error.

[C] Answer the following:

(a) To receive the string "We have got the guts, you get the glory!!" in an array **char str[100]** which of the following functions would you use?

1. scanf ("%s", str) ;
2. gets (str) ;
3. getche (str) ;
4. fgetchar (str) ;

Answer:

2. gets()

- (b) Which function would you use if a single key were to be received through the keyboard?

1. `scanf()`
2. `gets()`
3. `getche()`
4. `getchar()`

Answer:

3. `getche()`

- (c) If an integer is to be entered through the keyboard, which function would you use?

1. `scanf()`
2. `gets()`
3. `getche()`
4. `getchar()`

Answer:

1. `scanf()`

- (d) What is the difference between **`getchar()`**, **`fgetchar()`**, **`getch()`** and **`getche()`**?

Answer:

All receive a character from keyboard. There are minor differences in them:

`getchar()`: Receives a character from keyboard, but it is necessary to hit the enter key after the character.

`fgetchar()`: Same as **`getchar()`**. **`getchar()`** is a macro, whereas, **`fgetchar()`** is a function.

getch(): Receives a character from keyboard without echoing it on the screen

getche(): Receives a character from keyboard and echoes it on the screen

- (e) Which of the following can a format string of a **printf()** function contain:
1. Characters, format specifications and escape sequences
 2. Character, integers and floats
 3. Strings, integers and escape sequences
 4. Inverted commas, percentage sign and backslash character

Answer:

1. Characters, conversion specifications and escape sequences

- (f) The purpose of the field-width specifier in a **printf()** function is to:
1. Control the margins of the program listing
 2. Specify the maximum value of a number
 3. Control the size of font used to print numbers
 4. Specify how many columns would be used to print the number

Answer:

4. Specifies how many columns will be used to print the number

[D] Answer the following:

- (a) Define two functions **xgets()** and **xputs()** which work similar to the standard library functions **gets()** and **puts()**.

Program:

```
/* Function xgets( ) and xputs( ) */

# include <stdio.h>

void xputs ( char * );
void xgets ( char * );

int main( )
{
    char sent[ 100 ];

    xputs ( "Enter a sentence ... " );
    xgets ( sent );
    printf ( "\n\n" );
    xputs ( sent );

    return 0 ;
}

void xputs ( char *s )
{
    while(*s)
    {
        putchar ( *s );
        s++;
    }
}

void xgets ( char *s )
{
    int i ;
    char ch ;

    for ( i = 0 ; i <= 98 ; i++ )
    {
        ch = getch( ) ;
        if ( ch == '\r' )
```

```
    {
        *s = '\0' ;
        break ;
    }
    if ( ch == '\b' )
    {
        printf ( " \b" ) ;
        i-- ;
        s-- ;
    }
    else
    {
        *s = ch ;
        s++ ;
    }
}
}
```

- (b) Define a function **getint()**, which would receive a numeric string from the keyboard, convert it to an integer number and return the integer to the calling function. A sample usage of **getint()** is shown below:

```
#include <stdio.h>
int main( )
{
    int a ;
    a = getint( ) ;
    printf ( "you entered %d\n", a )
    return 0 ;
}
```

Program:

```
#include <stdio.h>
int getint( ) ;

int main( )
```

```
{
    int a ;

    printf ( "\nEnter a numeric string..." );
    a = getint( ) ;
    printf ( "You entered %d\n", a ) ;
    return 0 ;
}

int getint( )
{
    char str[ 6 ] ;
    int i, j, k, val ;

    i = 0 ;
    while ( i <= 5 )
    {
        str[ i ] = getche( ) ; /* string input from keyboard */
        if ( str[ i ] == '\r' )
        {
            str[ i ] = '\0' ;
            break ;
        }
        if ( str[ i ] == '\b' )
        {
            i-- ;
            printf ( " \b" ) ;
        }
        else
            i++ ;
    }
    val = 0 ;
    k = 1 ;
    for ( j = i - 1 ; j >= 0 ; j-- )
    {
        val = val + ( str[ j ] - 48 ) * k ; /* convert to numeric value */
        k = k * 10 ;
    }
}
```

```
    return ( val );  
}
```

- (c) Define a function **getfloat()**, which would receive a numeric string from the keyboard, convert it to a float value and return the float to the calling function.

Program:

```
/* Program to convert a string to a float value and return the float to the  
calling function */
```

```
# include <stdio.h>  
float getfloat( );
```

```
int main( )  
{  
    float floatresult = 0.0f ;  
  
    floatresult = getfloat( ) ;  
    printf ( "After converting string to float, result is : " ) ;  
    printf ( "%0.2f\n", floatresult ) ;  
    return 0 ;  
}
```

```
float getfloat( )  
{  
    char str[ ] = "1234.56" ;  
    float temp = 0.0f, result = 0.0f ;  
    int i, j, decimal ;  
  
    for ( i = 0 ; str[ i ] != '.' ; i++ )  
        result = ( result * 10 ) + str[ i ] - '0' ;  
  
    decimal = 1 ;  
  
    for ( j = i + 1 ; str[ j ] != '\0' ; j++ )
```



```

    {
        temp = str[j] - '0' ;
        decimal = decimal * 10 ;
        temp = temp / decimal ;
        result = result + temp ;
    }
    return result ;
}

```

- (d) If we are to display the following output properly aligned which format specifiers would you use?

Discovery of India	Jawaharlal Nehru	425.50
My Experiments with Truth	Mahatma Gandhi	375.50
Sunny Days	Sunil Gavaskar	95.50
One More Over	Erapalli Prasanna	85.00

Program:

```

#include <stdio.h>
int main( )
{
    printf ( "%-30s%-20s%-10.2f\n", "Discovery of India", "Jawaharlal
    Nehru", 425.50 ) ;

    printf ( "%-30s%-20s%-10.2f\n", "My Experiments with Truth",
    "Mahatma Gandhi", 375.50 ) ;

    printf ( "%-30s%-20s%-10.2f\n", "Sunny Days", "Sunil Gavaskar",
    95.50 ) ;

    printf ( "%-30s%-20s%-10.2f\n", "One More Over", "Erapalli
    Prasanna", 85.00 ) ;

    return 0 ;
}

```

CHAPTER

NINETEEN

File Input/Output

[A] Point out the errors, if any, in the following programs:

```
(a) #include <stdio.h>
void openfile ( char *, FILE ** );
int main( )
{
    FILE *fp ;
    openfile ( "Myfile.txt", fp );
    if ( fp == NULL )
        printf ( "Unable to open file...\n" );
    return 0 ;
}
void openfile ( char *fn, FILE **f )
{
    *f = fopen ( fn, "r" );
}
```

No Error.

```
(b) #include <stdio.h>
#include <stdlib.h>
int main( )
{
    FILE *fp ;
    char c ;
    fp = fopen ( "TRY.C" ,"r" );
```

```
if ( fp == null )
{
    puts ( "Cannot open file\n" );
    exit( ) ;
}
while ( ( c = getc ( fp ) ) != EOF )
    putchar ( c );
fclose ( fp );
return 0 ;
}
```

Error. NULL should be used instead of null and few arguments for call to **exit()** function.

```
(c) #include <stdio.h>
int main( )
{
    char fname[ ] = "c:\\students.dat" ;
    FILE *fp ;
    fp = fopen ( fname, "tr" );
    if ( fp == NULL )
        printf ( "Unable to open file...\n" );
    return 0 ;
}
```

Error. Undefined symbol FILE. The header file "stdio.h" should be included.

```
(d) #include <stdio.h>
int main( )
{
    FILE *fp ;
    char str[ 80 ];
    fp = fopen ( "TRY.C", "r" );
    while ( fgets ( str, 80, fp ) != EOF )
        fputs ( str );
    fclose ( fp );
}
```

```
    return 0 ;  
}
```

Error. 'stdio.h' should be included. **fputs()** needs two arguments. NULL should be used with **fgets()** to check end of file.

```
(e) #include <stdio.h>  
int main( )  
{  
    unsigned char ;  
    FILE *fp ;  
  
    fp = fopen ( "trial", 'r' ) ;  
    while ( ( ch = getc ( fp ) ) != EOF )  
        printf ( "%c", ch ) ;  
  
    fclose ( *fp ) ;  
    return 0 ;  
}
```

Error. Type mismatch in parameter '__mode' in call to 'fopen'.

Error. Undefined symbol 'ch'

Error. Type mismatch in parameter '__stream' in call to 'fclose'.

```
(f) #include <stdio.h>  
int main( )  
{  
    FILE *fp ;  
    char names[ 20 ] ;  
    int i ;  
    fp = fopen ( "students.dat", "wb" ) ;  
    for ( i = 0 ; i <= 10 ; i++ )  
    {  
        puts ( "\nEnter name: " ) ;  
        gets ( name ) ;  
        fwrite ( name, size of ( name ), 1, fp ) ;  
    }
```

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

Error. The header file 'stdio.h' should be included. **sizeof** should be one word. **fclose()** should be used to close the file.

```
(g) #include <stdio.h>  
int main( )  
{  
    FILE *fp ;  
    char name[ 20 ] = "Ajay" ;  
    int i ;  
    fp = fopen ( "students.dat", "r" ) ;  
    for ( i = 0 ; i <= 10 ; i++ )  
        fwrite ( name, sizeof ( name ), 1, fp ) ;  
    close ( fp ) ;  
    return 0 ;  
}
```

Error. The header file 'stdio.h' should be included. **sizeof** should be one word. **fclose()** should be used to close the file.

```
(h) #include <fcntl.h>  
#include <stdio.h>  
int main( )  
{  
    int fp ;  
    fp = open ( "pr22.c", "r" ) ;  
    if ( fp == -1 )  
        puts ( "cannot open file\n" ) ;  
    else  
        close ( fp ) ;  
    return 0 ;  
}
```

Error. `O_RDONLY` should be used in place of “r” while opening the file.

```
(i) #include <stdio.h>
int main( )
{
    int fp ;
    fp = fopen ( "students.dat", READ | BINARY ) ;
    if ( fp == -1 )
        puts ( "cannot open file\n" ) ;
    else
        close ( fp ) ;
    return 0 ;
}
```

Error. "stat.h" should be included instead of "STDIO.H". Also, in place of `READ` and `BINARY`, `O_RDONLY` and `O_BINARY` should be used.

[B] Answer the following:

(a) The `FILE` structure is defined in which of the following files:

1. `stdlib.h`
2. `stdio.c`
3. `io.h`
4. `stdio.h`

Answer:

4. `stdio.h`

(b) If a file contains the line “I am a boy\r\n” then on reading this line into the array `str[]` using `fgets()` what would `str[]` contain?

1. I am a boy\r\n\0

2. I am a boy\r\0
3. I am a boy\n\0
4. I am a boy

Answer:

1. I am a boy\r\n\0

(c) State True or False:

1. The disadvantage of High Level file I/O functions is that the programmer has to manage the file buffers.

Answer: False

2. If a file is opened for reading, it is necessary that the file must exist.

Answer: True

3. If a file opened for writing already exists, its contents would be overwritten.

Answer: True

4. For opening a file in append mode it is necessary that the file should exist.

Answer: False

(d) On opening a file for reading which of the following activities are performed:

1. The disk is searched for existence of the file.
2. The file is brought into memory.
3. A pointer is set up which points to the first character in the file.
4. All the above.

Answer:

4. All the above

- (e) Is it necessary that a file created in text mode must always be opened in text mode for subsequent operations?

Answer:

Yes

- (f) While using the statement,

```
fp = fopen ( "myfile.c", "r" );
```

what happens if,

- ‘myfile.c’ does not exist on the disk
- ‘myfile.c’ exists on the disk

Answer:

If myfile.c does not exist on the disk it returns a NULL

If myfile.c exists on the disk then the file is loaded into memory and a file pointer is set up which points to the first character in the file

- (g) What is the purpose of the library function **fflush()**?

Answer:

Clear the specified buffer **fflush (stdin)** clears the keyboard buffer

- (h) While using the statement,

```
fp = fopen ( "myfile.c", "wb" );
```

what happens if,

- ‘myfile.c’ does not exist on the disk.

- ‘myfile.c’ exists on the disk

Answer:

If file does not exist on disk then a new file is created.

If file exists on disk then the file is destroyed and a new file is created

- (i) A floating-point array contains percentage marks obtained by students in an examination. To store these marks in a file ‘marks.dat’, in which mode would you open the file and why?

Answer:

Open the file in binary mode since in binary mode a float occupies only four bytes when stored in a file unlike the text mode file in which number of bytes occupied by a float depends upon the length of the float.

[C] Attempt the following:

- (a) Write a program to read a file and display its contents along with line numbers before each line.

Program:

```
/* Program to display a file with line numbers */
# include <stdio.h>

int main( )
{
    FILE *fp ;
    char ch ;
    char source[ 67 ] ;
    int count = 1 ;

    puts ( "Enter the file name : " ) ;
    gets ( source ) ;
```

```
fp = fopen ( source, "r" ); /* read only mode for the source file */

if ( fp == NULL )
{
    puts ( "Unable to open the file." );
    exit ( 0 );
}

system ( "cls" );
printf ( "Filename : %s", source );

printf ( "\nLine :- %d\t", count );
while ( ( ch = getc( fp ) ) != EOF )
{
    if ( ch == '\n' )
    {
        count++;
        printf ( "\nLine :- %d\t", count );
    }
    else
        printf ( "%c", ch );
}

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

- (b) Write a program to append the contents of one file at the end of another.

Program:

```
/* Copy the contents of two files alternatively in a new text file */
# include <stdio.h>
# include <string.h>
int main( )
```

```
{
    FILE *fs1, *fs2, *ft ;
    char str1[ 80 ], str2[ 80 ], source1[ 67 ], source2[ 67 ], target[ 67 ] ;
    char *ptrch, newl = '\n' ;
    int flag = 0 ;

    puts ( "Enter source1 file name: " ) ;
    gets ( source1 ) ;

    puts ( "Enter source2 file name: " ) ;
    gets ( source2 ) ;

    puts ( "Enter target file name: " ) ;
    gets ( target ) ;

    fs1 = fopen ( source1, "r" ) ; /* read only mode for source file */

    if ( fs1 == NULL )
    {
        puts ( "Unable to open source1" ) ;
        exit ( 0 ) ;
    }

    fs2 = fopen ( source2, "r" ) ; /* read only mode for source file */
    if ( fs2 == NULL )
    {
        puts ( "Unable to open source2" ) ;
        fclose ( fs2 ) ;
        exit ( 0 ) ;
    }

    ft = fopen ( target, "w+" ) ; /* write / modify mode for target file */

    if ( ft == NULL )
    {
        fclose ( fs1 ) ;
        fclose ( fs2 ) ;
        puts ( "Unable to create target file." ) ;
    }
}
```

```
        exit ( 0 ) ;
    }

    /* read the source files and copy them one after another */
    /* read till the eof of the first file is reached */
    while ( fgets ( str1, 79, fs1 ) != NULL )
    {
        ptrch = strchr ( str1, newl ) ;
        fputs ( str1, ft ) ;
        if ( !ptrch )
            fputs ( "\n", ft ) ;
    }

    /* copy the contents of the second file */
    while ( fgets ( str2, 79, fs2 ) != NULL )
    {
        ptrch = strchr ( str2, newl ) ;
        fputs ( str2, ft ) ;
        if ( !ptrch )
            fputs ( "\n", ft ) ;
    }

    printf ( "\nCopying files completed!!" ) ;
    fclose ( fs1 ) ;
    fclose ( fs2 ) ;
    fclose ( ft ) ;

    return 0 ;
}
```

- (c) Suppose a file contains student's records with each record containing name and age of a student. Write a program to read these records and display them in sorted order by name.

Program:

```
/* Read records from a file & display them in alphabetical order by
names */
/* Note that 'STUDENT.DAT' file is already created and data written in it
using fwrite() */

# include <stdio.h>

int main( )
{
    FILE *fp ;
    struct stud
    {
        char name[ 40 ] ;
        int age ;
    };
    struct stud s, stud[ 10 ], temp ;
    int n, j, k, ii ;

    fp = fopen ( "STUDENT.DAT", "rb" ) ;

    n = 0 ;
    while ( fread ( &s, sizeof ( s ), 1, fp ) == 1 )
    {
        stud[ n ] = s ;
        n++ ;
    }

    for ( j = 0 ; j < n - 1 ; j++ )
    {
        for ( k = j + 1 ; k < n ; k++ )
        {
            if ( strcmp ( stud[ j ].name, stud[ k ].name ) > 0 )
            {
                temp = stud[ j ] ;
                stud[ j ] = stud[ k ] ;
                stud[ k ] = temp ;
            }
        }
    }
}
```

```
    }

    fclose ( fp );

    for ( j = 0 ; j < n ; j++ )
        printf ( "Name: %s , age: %d\n", stud[j].name, stud[j].age );

    return 0 ;
}
```

- (d) Write a program to copy contents of one file to another. While doing so replace all lowercase characters to their equivalent uppercase characters.

Program:

```
/* Program to copy one text file to another and replace all lower case
characters to upper case */
# include <stdio.h>

int main( )
{
    FILE *fs, *ft ;
    char ch ;
    char  source[ 67 ], target[ 67 ] ;

    puts ( "Enter source file name: " ) ;
    gets ( source ) ;

    puts ( "Enter target file name: " ) ;
    gets ( target ) ;

    fs = fopen ( source, "r" ) ; /* read only mode for source file */

    if ( fs == NULL )
    {
        puts ( "Unable to open source file" ) ;
        exit ( 0 ) ;
    }
}
```

```
    }

    ft = fopen ( target, "w+" ); /* write / modify mode for target file */

    if ( ft == NULL )
    {
        fclose ( fs );
        puts ( "Unable to open target file" );
        exit ( 0 );
    }

    while ( 1 )
    {
        ch = fgetc ( fs );

        if ( ch == EOF )
            break ;
        else
        {
            /* replace lower case character by upper case character */
            if ( islower ( ch ) )
                fputc ( toupper ( ch ), ft );
            else
                fputc ( ch, ft );
        }
    }
    printf ( "\nFile copied!!\n" );
    fclose ( fs );
    fclose ( ft );

    return 0 ;
}
```

- (e) Write a program that merges lines alternately from two files and writes the results to new file. If one file has less number of lines than the other, the remaining lines from the larger file should be simply copied into the target file.

Program:

```
/* Copy the contents of two files alternatively in a new text file */
# include <stdio.h>
# include <string.h>

int main( )
{
    FILE *fs1, *fs2, *ft ;
    char str1[ 80 ], str2[ 80 ], source1[ 67 ], source2[ 67 ], target[ 67 ] ;
    char *ptrch, newl = '\n' ;
    int flag = 0 ;

    puts ( "Enter source1 file name: " ) ;
    gets ( source1 ) ;

    puts ( "Enter source2 file name: " ) ;
    gets ( source2 ) ;

    puts ( "Enter target file name: " ) ;
    gets ( target ) ;

    fs1 = fopen ( source1, "r" ) ; /* read only mode for source file */

    if ( fs1 == NULL )
    {
        puts ( "Unable to open source1" ) ;
        exit ( 0 ) ;
    }

    fs2 = fopen ( source2, "r" ) ; /* read only mode for source file */
    if ( fs2 == NULL )
    {
        puts ( "Unable to open source2" ) ;
        fclose ( fs2 ) ;
        exit ( 0 ) ;
    }
}
```



```
ft = fopen ( target, "w+" ); /* write / modify mode for target file */

if ( ft == NULL )
{
    fclose ( fs1 );
    fclose ( fs2 );
    puts ( "Unable to create target file" );
    exit ( 0 );
}

/* read the source files and copy the strings alternately */
/* read till the eof of any one of the files is reached */
while ( fgets ( str1, 79, fs1 ) != NULL )
{
    ptrch = strchr ( str1, newl );
    fputs ( str1, ft );
    if ( !ptrch )
        fputs ( "\n", ft );

    if ( fgets ( str2, 79, fs2 ) != NULL )
    {
        fputs ( str2, ft );
        ptrch = strchr ( str2, newl );
        flag = 1 ;
        if ( !ptrch )
            fputs ( "\n", ft );
    }
    else
        fputs ( "\n", ft );
}

/* copy the contents of the file whose eof is not reached */
if ( flag == 1 )
{
    while ( fgets ( str2, 79, fs2 ) != NULL )
    {
        ptrch = strchr ( str1, newl );
        fputs ( str2, ft );
    }
}
```

```

        if ( ptrch )
            fputs ( "\n", ft );
    }

    printf ( "\nCopying files completed!!\n" );
    fclose ( fs1 );
    fclose ( fs2 );
    fclose ( ft );

    return 0 ;
}

```

- (f) Write a program to display the contents of a text file on the screen. Make following provisions:

Display the contents inside a box drawn with opposite corner co-ordinates being (0, 1) and (79, 23). Display the name of the file whose contents are being displayed, and the page numbers in the zeroth row. The moment one screenful of file has been displayed, flash a message ‘Press any key...’ in 24th row. When a key is hit, the next page’s contents should be displayed, and so on till the end of file.

Program:

```

/* Display the contents of a file */
# include <stdio.h>
# include <windows.h>

void drawbox ( int, int, int, int );
void gotoxy ( short int col, short int row );

int main ( int argc, char *argv[ ] )
{
    FILE *fp ;
    char ch ;
    int pg = 1, r = 2, c = 1 ;

```

```
if ( argc != 2 )
{
    puts ( "Incorrect usage... " );
    exit ( 1 );
}
fp = fopen ( argv[ 1 ], "r" );
if ( fp == NULL )
{
    puts ( "Cannot open source file ... " );
    exit ( 2 );
}

drawbox ( 1, 0, 22, 79 );
gotoxy ( 0, 0 );
printf ( "Filename : %s", argv[ 1 ] );
gotoxy ( 65, 0 );
printf ( "Page :- %d", pg );

while ( ( ch = getc ( fp ) ) != EOF )
{
    if ( ch != '\n' )
    {
        gotoxy ( r, c );
        printf ( "%c", ch );
        c++;
    }
    else
    {
        r++;
        c = 1;
        if ( r > 20 )
        {
            pg++;
            r = 2;
            gotoxy ( 0, 23 );
            puts ( "Press any key ... " );
            system ( "cls" );
        }
    }
}
```

```
        drawbox ( 1, 0, 22, 79 );
        gotoxy ( 0, 0 );
        printf ( "Filename : %s", argv[ 1 ] );
        gotoxy ( 65, 0 );
        printf ( "Page : %d", pg );
    }
}
}
fclose ( fp );
return 0 ;
}

void drawbox ( int a, int b, int i, int j )
{
    int x, k ;
    gotoxy ( b, a );
    printf ( "%c", 201 );
    gotoxy ( b, i );
    printf ( "%c", 200 );
    gotoxy ( j, i );
    printf ( "%c", 188 );
    gotoxy ( j, a );
    printf ( "%c", 187 );

    for ( x = a + 1 ; x <= i - 1 ; x++ )
    {
        gotoxy ( b, x );
        printf ( "%c", 186 );
        gotoxy ( j, x );
        printf ( "%c", 186 );
    }
    for ( k = b + 1 ; k <= j - 1 ; k++ )
    {
        gotoxy ( k, a );
        printf ( "%c", 205 );
        gotoxy ( k, i );
        printf ( "%c", 205 );
    }
}
```

```

}

void gotoxy ( short int col, short int row )
{
    HANDLE hStdout = GetStdHandle ( STD_OUTPUT_HANDLE );
    COORD position = { col, row };
    SetConsoleCursorPosition ( hStdout, position );
}

```

(g) Write a program to encrypt/decrypt a file using:

- (1) An offset cipher: In an offset cipher each character from the source file is offset with a fixed value and then written to the target file.
For example, if character read from the source file is 'A', then convert this into a new character by offsetting 'A' by a fixed value, say 128, and then writing the new character to the target file.

Program:

```

/* Encrypt / Decrypt a file using offset cipher */
#include <stdio.h>

FILE *fs, *ft;
void code();
void decode();

int main ( int argc, char *argv[ ] )
{
    if ( argc != 4 )
    {
        puts ( "Improper usage. Correct usage is:\n" );
        puts ( "CH11GF1 <source file> <target file> <C/D>\n" );
        exit ( 1 );
    }
    fs = fopen ( argv[ 1 ], "r" );
    if ( fs == NULL )

```

```
{
    printf ( "Cannot open source file\n" );
    puts ( argv[ 1 ] );
    exit ( 2 );
}
ft = fopen ( argv[ 2 ], "w" );
if ( ft == NULL )
{
    puts ( "Cannot open target file\n" );
    puts ( argv[ 2 ] );
    fclose ( fs );
    exit ( 3 );
}
if ( *argv[ 3 ] == 'c' || *argv[ 3 ] == 'C' )
    code();
else
    decode();

fclose ( fs );
fclose ( ft );

printf ( "Mission Accomplished\n" );
return 0;
}

void code( )
{
    int ch;

    while ( ( ch = getc ( fs ) ) != EOF )
    {
        ch = ch + 128; /* encrypt - offset each character by 128 */
        putc ( ch, ft );
    }
}

void decode( )
{

```

```

int ch ;

while ( ( ch = getc ( fs ) ) != EOF )
{
    ch = ch - 128 ; /* decrypt - offset each character by -128 */
    putc ( ch, ft ) ;
}
}

```

- (2) A substitution cipher: In this each character read from the source file is substituted by a corresponding predetermined character and this character is written to the target file.

For example, if character 'A' is read from the source file, and if we have decided that every 'A' is to be substituted by '!', then a '!' would be written to the target file in place of every 'A'. Similarly, every 'B' would be substituted by '5' and so on.

Program:

```

/* Encrypt / Decrypt a file using substitution cipher */
#include <stdio.h>

FILE *fs, *ft ;
void code( ) ;
void decode( ) ;

int main ( int argc, char *argv[ ] )
{
    if ( argc != 4 )
    {
        puts ( "Improper usage. Correct usage is:\n" ) ;
        puts ( "CH11GF2 <source file> <target file> C/D\n" ) ;
        exit ( 1 ) ;
    }
    fs = fopen ( argv[ 1 ], "r" ) ; /* source file - read only mode */

```

```
if ( fs == NULL )
{
    puts ( "Cannot open source file\n" );
    exit ( 2 );
}
ft = fopen ( argv[ 2 ], "w" ); /* target file - write mode */
if ( ft == NULL )
{
    puts ( "Cannot open target file\n" );
    fclose ( fs );
    exit ( 3 );
}
if ( *argv[ 3 ] == 'c' || *argv[ 3 ] == 'C' )
    code();
else
{
    if ( *argv[ 3 ] == 'd' || *argv[ 3 ] == 'D' )
        decode();
    else
    {
        fclose ( fs );
        fclose ( ft );
        puts ( "Improper usage\n" );
        exit ( 4 );
    }
}

fclose ( fs );
fclose ( ft );

return 0 ;
}

void code( )
{
    char ch ;
    int i = 0 ;
    char arr1[ 97 ] = "IOP{}asdfghjkl;'ASDFGHJKL:zxcvbn
```



```

m,./ZXCVBNM<>?'`1234567890-=\~!@#
$%^&*(_+|qwertyuiop[ ]QWERTYU" ;

char arr2[ 97 ] = "`1234567890-=\~!@#$$%^&*(_+|qw
ertyuiop[ ]QWERTYUIOP{}asdfghjkl;'A
SDFGHJKL:zxcvbnm,./ZXCVBNM<>?'";

arr2[ 93 ] = '\\';
arr1[ 93 ] = '\\';
arr2[ 94 ] = '\"';
arr1[ 94 ] = '\"';
arr2[ 95 ] = '\n';
arr1[ 95 ] = '\n';
arr1[ 96 ] = '\t';
arr2[ 96 ] = '\t';

while ( ( ch = getc ( fs ) ) != EOF )
{
    for ( i = 0 ; i <= 96 ; i++ )
    {
        if ( ch == arr1[ i ] )
            break ;
    }
    putc ( arr2[ i ], ft ) ;
}

void decode( )
{
    char ch ;
    int i = 0 ;
    char arr1[ 97 ] = " IOP{}asdfghjkl;'ASDFGHJKL:zxcvbn
m,./ZXCVBNM<>?'`1234567890-=~!@#
$%^&*(_+|qwertyuiop[ ]QWERTYU" ;
    char arr2[ 97 ] = "`1234567890-=~!@#$$%^&*(_+|qw
ertyuiop[ ]QWERTYUIOP{}asdfghjkl;'A
SDFGHJKL:zxcvbnm,./ZXCVBNM<>?'";

    arr2[ 93 ] = '\\';
    arr1[ 93 ] = '\\';

```

```
arr2[ 94 ] = \"\" ;
arr1[ 94 ] = \"\" ;
arr2[ 95 ] = \"\\n\" ;
arr1[ 95 ] = \"\\n\" ;
arr1[ 96 ] = \"\\t\" ;
arr2[ 96 ] = \"\\t\" ;

while ( ( ch = getc ( fs ) ) != EOF )
{
    for ( i = 0 ; i <= 96 ; i++ )
    {
        if ( ch == arr2[ i ] )
            break ;
    }
    putc ( arr1[ i ], ft ) ;
}
}
```

- (h) In the file 'CUSTOMER.DAT' there are 100 records with the following structure:

```
struct customer
{
    int accno ;
    char name[ 30 ] ;
    float balance ;
};
```

In another file 'TRANSACTIONS.DAT' there are several records with the following structure:

```
struct trans
{
    int accno ;
    char trans_type ;
    float amount ;
};
```

The element **trans_type** contains D/W indicating deposit or withdrawal of amount. Write a program to update 'CUSTOMER.DAT' file, i.e. if the **trans_type** is 'D' then update the **balance** of 'CUSTOMER.DAT' by adding **amount** to balance for the corresponding **accno**. Similarly, if **trans_type** is 'W' then subtract the **amount** from **balance**. However, while subtracting the amount ensure that the amount should not get overdrawn, i.e. at least 100 Rs. Should remain in the account.

Program:

```
/* To copy a field from a data file to another data file */
#include <stdio.h>

struct customer
{
    int accno ;
    char name[ 30 ] ;
    float balance ;
};

struct trans
{
    int accno ;
    char trans_type ;
    float amount ;
};

int main( )
{
    struct customer s ;
    struct trans ss ;
    FILE *fs , *ft ;
    int slen = sizeof ( struct customer ) ;

    fs = fopen ( "TRANSACTION.DAT", "rb" ) ;
    if ( fs == NULL )
```

```
{
    puts ( "Cannot open file: TRANSACTION.DAT\n" );
    exit ( 1 );
}

ft = fopen ( "CUSTOMER.DAT", "rb+" );

if ( ft == NULL )
{
    puts ( "Cannot open file: CUSTOMER.DAT\n" );
    fclose ( fs );
    exit ( 2 );
}

while ( fread ( &ss, sizeof ( ss ), 1, fs ) == 1 )
{
    fseek ( ft, 0, SEEK_SET );
    while ( fread ( &s, slen, 1, ft ) == 1 )
    {
        if ( s.accno == ss.accno )
        {
            if ( ss.trans_type == 'D' )
                s.balance += ss.amount ;
            else
            {
                if ( ( ss.trans_type == 'W' ) &&
                    ( s.balance - ss.amount > 100 ) )
                    s.balance -= ss.amount ;
                else
                    s.balance = 100 ;
            }
        }
        fseek ( ft, -slen, SEEK_CUR );
        fwrite ( &s, slen, 1, ft );
        break ;
    }
}
}
```

```
    fclose ( fs );
    fclose ( ft );

    return 0 ;
}
```

- (i) There are 100 records present in a file with the following structure:

```
struct date
{
    int d, m, y ;
};

struct employee
{
    int empcode[ 6 ] ;
    char empname[ 20 ] ;
    struct date join_date ;
    float salary ;
};
```

Write a program to read these records, arrange them in ascending order by **join_date** and write them to a target file.

Program:

```
/* To arrange records in a file in ascending order of joining date */
#include <stdio.h>

struct date
{
    int d, m, y ;
};
int isgreater ( struct date, struct date ) ;

int main( )
{
```

```
struct employee
{
    int empcode[ 6 ];
    char empname[ 20 ];
    struct date join_date ;
    float salary ;
};

struct employee emp[ 100 ], s, temp ;
int j, k ;
FILE *fs, *ft ;
int n ;

fs = fopen ( "EMP.DAT", "rb" );
if ( fs == NULL )
{
    puts ( "Cannot open file: EMP.DAT\n" );
    exit ( 1 );
}

ft = fopen ( "ASCEMP.DAT", "wb" );
if ( ft == NULL )
{
    puts ( "Cannot open file: ASCEMP.DAT\n" );
    fclose ( fs );
    exit ( 2 );
}

n = 0 ;
while ( fread ( &s, sizeof( s ), 1, fs ) == 1 )
{
    emp[ n ] = s ;
    n++ ;
}

for ( j = 0 ; j < n - 1 ; j++ )
{
    for ( k = j + 1 ; k < n ; k++ )
```

```

        {
            if ( isgreater ( emp[ j ].join_date, emp[ k ].join_date ))
            {
                temp = emp[ j ];
                emp[ j ] = emp[ k ];
                emp[ k ] = temp ;
            }
        }
    }

    for ( j = 0 ; j < n ; j++ )
        fwrite ( &emp[ j ], sizeof ( s ), 1, ft );

    fclose ( fs );
    fclose ( ft );

    printf ( "Records arranged in ascending order\n" );
    return 0 ;
}

int isgreater ( struct date d1, struct date d2 )
{
    if ( d1.y > d2.y )
        return ( 1 );
    else
    {
        if ( d1.y == d2.y )
        {
            if ( d1.m > d2.m )
                return ( 1 );
            else
            {
                if ( ( d1.m == d2.m ) && ( d1.d >= d2.d ) )
                    return ( 1 );
            }
        }
    }
}

return 0 ;

```

```
}
```

- (j) A hospital keeps a file of blood donors in which each record has the format:

Name: 20 Columns

Address: 40 Columns

Age: 2 Columns

Blood Type: 1 Column (Type 1, 2, 3 or 4)

Write a program to read the file and print a list of all blood donors whose age is below 25 and whose blood type is 2.

Program:

```
/* To Read file in binary mode and display its contents */
```

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

```
int main( )
```

```
{
```

```
    struct donors
```

```
    {
```

```
        char name[ 21 ];
```

```
        char address[ 41 ];
```

```
        int age;
```

```
        char bloodtype;
```

```
    };
```

```
    struct donors hospital;
```

```
    FILE *fp;
```

```
    fp = fopen ( "hospital.dat", "rb" ); /* read only in binary mode */
```

```
    if ( fp == NULL )
```

```
    {
```

```
        puts ( "Cannot open file\n" );
```

```
        exit ( 1 );
```

```
    }
```



```
while ( fread ( &hospital, sizeof ( hospital ), 1, fp ) == 1 )
{
    if ( hospital.age < 25 && hospital.bloodtype == '2' )
        printf ( "%s %s %d %c\n", hospital.name, hospital.address,
                hospital.age, hospital.bloodtype ) ;
}

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

/* In order to run this program, you must have a file "Hospital.dat". If you do not have such a file, you can use the following code to create this file with 5 records. */

```
# include <stdio.h>

int main( )
{
    struct donors
    {
        char name[ 21 ] ;
        char address[ 41 ] ;
        int age ;
        char bloodtype ;
    } ;
    struct donors hospital ;
    int i ;
    FILE *fp ;

    fp = fopen ( "hospital.dat", "wb" ) ;
    if ( fp == NULL )
    {
        puts ( "Cannot open file\n" ) ;
        exit ( 1 ) ;
    }
}
```

```
for ( i = 0 ; i < 5 ; i ++ )
{
    printf ( "\nName: " ) ;
    scanf ( "%s", hospital.name ) ;
    fflush ( stdin ) ;
    printf ( "\nAddress: " ) ;
    scanf ( "%s", hospital.address ) ;
    fflush ( stdin ) ;
    printf ( "\nAge: " ) ;
    scanf ( "%d", &hospital.age ) ;
    fflush ( stdin ) ;
    printf ( "\nType: " ) ;
    scanf ( "%c", &hospital.bloodtype ) ;
    fflush ( stdin ) ;

    fwrite ( &hospital, sizeof ( hospital ), 1, fp ) ;
}

fcloseall ( ) ;
return 0 ;
}
```

- (k) Given a list of names of students in a class, write a program to store the names in a file on disk. Make a provision to display the n^{th} name in the list (n is data to be read) and to display all names starting with S.

Program:

```
/* Create a file on disk, retrieve data as required */
# include <stdio.h>

int main( )
{
    FILE *fp ;
    char name[ 21 ], ch, another = 'y' ;
    int num, n ;
```

```
fp = fopen ( "student.dat", "w+" ); /* open a file in write mode */

if ( fp == NULL )
{
    puts ( "Unable to create file\n" );
    exit ( 1 );
}

/* Loop for data entry */
while ( another == 'y' || another == 'Y' )
{
    puts ( "\nEnter the name of student: " );
    gets ( name );

    fputs ( name, fp ); /* write data to file */
    fputs ( "\n", fp ); /* add newline character at the end
                        of record */

    puts ( "Do you want to add more names y/n" );
    fflush ( stdin );
    another = getch();
}

fseek ( fp, 0L, SEEK_SET ); /* File pointer reset to start of the file */

puts ( "\nEnter any number from the list" );
scanf ( "%d", &num );
n = num ;
while ( fgets ( name, 21, fp ) != NULL )
{
    num--; /* count downwards to reach the required record */
    if ( num == 0 )
        printf ( "\nThe name of student no. %d is: %s\n", n, name );
}

if ( num > 0 )
    puts ( "No such number exists in the list\n" );
```

```

fseek ( fp, 0L, SEEK_SET ); /* reset file pointer */

puts ( "\nList of students whose name starts with S: " );

while ( fgets ( name, 21, fp ) != NULL )
{
    if ( name[ 0 ] == 's' || name[ 0 ] == 'S' )
        printf ( "%s", name );
}

fclose ( fp );
return 0 ;
}

```

- (l) Assume that a Master file contains two fields, Roll no. and name of the student. At the end of the year, a set of students join the class and another set leaves. A Transaction file contains the roll numbers and an appropriate code to add or delete a student.

Write a program to create another file that contains the updated list of names and roll numbers. Assume that the Master file and the Transaction file are arranged in ascending order by roll numbers. The updated file should also be in ascending order by roll numbers.

Program:

```

/* Create an updated file from Master & Transaction File */
#include <stdio.h>

int main( )
{
    FILE *mf, *tf, *uf ;

    struct master /* Master file structure */
    {

```

```
    int rollno ;
    char name[ 20 ] ;
};

struct transaction /* Transaction file structure */
{
    char code ;
    int rollup ;
    char name1[ 20 ] ;
};

struct master student, newstudent ;
struct transaction add_del ;
int msz = sizeof ( struct master ) ;

mf = fopen ( "master.dat", "r" ) ; /* read only mode */

if ( mf == NULL )
{
    puts ( "Unable to open master file\n" ) ;
    exit ( 1 ) ;
}

tf = fopen ( "transact.dat", "r" ) ; /* read only mode */

if ( tf == NULL )
{
    puts ( "Unable to open transaction file\n" ) ;
    fclose ( mf ) ;
    exit ( 2 ) ;
}

uf = fopen ( "updated.dat", "w+" ) ; /* write and modify mode */

if ( uf == NULL )
{
    puts ( "Unable to create updated file\n" ) ;
    fclose ( mf ) ;
}
```

```
        fclose ( tf );
        exit ( 3 );
    }

    while ( fread ( &add_del, sizeof ( struct transaction ), 1, tf ) == 1 )
    {
        fread ( &student, msz, 1, mf );

        /* if code = d, don't do anything */
        if ( add_del.code == 'd' )
        {
            if ( student.rollno == add_del.rollup )
                continue ;
            else
            {
                /* code != d, write to updated file from master file */
                while ( student.rollno != add_del.rollup )
                {
                    fwrite ( &student, msz, 1, uf );
                    fread ( &student, msz, 1, mf );
                }
            }
            continue ;
        }

        /* write all records from master file to updated file where roll no
           of master file < roll no of transaction file */
        while ( student.rollno < add_del.rollup )
        {
            fwrite ( &student, msz, 1, uf );
            fread ( &student, msz, 1, mf );
        }
        /* copy record from transaction file to updated file where
           code != d ( new student has to be added ) */
        newstudent.rollno = add_del.rollup ;
        strcpy ( newstudent.name, add_del.name1 );

        fwrite ( &newstudent, msz, 1, uf );
    }
}
```

```
        fseek ( mf,-msz, SEEK_CUR );

    } /* end of while loop */

    /* write rest of the records from master file to updated file for which
       there is no matching record in transaction file */
    while ( fread ( &student, msz, 1, mf ) == 1 )
        fwrite ( &student, msz, 1, uf );

    fclose ( mf );
    fclose ( tf );
    fclose ( uf );

    printf ( "Updated file saved\n" );
    return 0 ;
}

/* The "master.dat" and "transact.dat" file can be created using the
   following code. Pl. ensure that your directory is correctly set. */

#include <stdio.h>

int main( )
{
    FILE *mf, *tf, *uf ;

    struct master
    {
        int rollno ;
        char name[ 20 ] ;
    };

    struct transaction
    {
        char code ;
        int rollup ;
        char name1[ 20 ] ;
```

```
};

struct master student, newstudent ;
struct transaction add_del ;
int i, msz = sizeof ( struct master ) ;
mf = fopen ( "master.dat", "w" ) ;
if ( mf == NULL )
{
    puts ( "Unable to open master file\n" ) ;
    exit ( 1 ) ;
}
for ( i = 0 ; i <= 2 ; i++ )
{
    printf ( "\nRollno: " ) ;
    scanf ( "%d", &student.rollno ) ;
    fflush ( stdin ) ;
    printf ( "\nName: " ) ;
    scanf ( "%s", &student.name ) ;
    fflush ( stdin ) ;
    fwrite ( &student, sizeof ( student ), 1, mf ) ;
}
fcloseall( ) ;

tf = fopen ( "transact.dat", "w" ) ;

if ( tf == NULL )
{
    puts ( "Unable to open master file\n" ) ;
    exit ( 2 ) ;
}

for ( i = 0 ; i <= 1 ; i++ )
{
    printf ( "\nCode: " ) ;
    scanf ( "%c", &add_del.code ) ;
    fflush ( stdin ) ;
    printf ( "\nRollno: " ) ;
    scanf ( "%d", &add_del.rollup ) ;
```



```

        fflush ( stdin );
        printf ( "\nName: " );
        scanf ( "%s", &add_del.name1 );
        fflush ( stdin );
        fwrite ( &add_del, sizeof ( add_del ), 1, tf );
    }

    fcloseall( );
    return 0 ;
}

```

(m) In a small firm employee numbers are given in serial numerical order, that is 1, 2, 3, etc.

- Create a file of employee data with following information: employee number, name, sex, gross salary.
- If more employees join, append their data to the file.
- If an employee with serial number 25 (say) leaves, delete the record by making gross salary 0.
- If some employee's gross salary increases, retrieve the record and update the salary.

Write a program to implement the above operations.

Program:

```

/* Maintain an Employee record in a small firm */

/* If the "emp.dat" file does not exist, this program can be used to create
the file and add some records to it using the "add" choice. */

#include <stdio.h>

int main( )
{
    struct employee
    {
        int empno ;

```

```
        char name[ 20 ];
        char sex ;
        float gs ;
    } emp ;

    FILE *fp ;
    char another ;
    int delno, flag, choice ;
    float newgs ;
    long sz = sizeof ( struct employee ) ;

    fp = fopen ( "emp.dat", "rb+" ) ; /* binary read / modify mode */
    if ( fp == NULL )
    {
        fp = fopen ( "emp.dat", "wb+" ) ; /* binary write / modify mode */
        if ( fp == NULL )
        {
            puts ( "Unable to open file\n" ) ;
            exit ( 1 ) ;
        }
    }

    /* display Menu */
    while ( 1 )
    {
        printf ( "1. Add\n" ) ;
        printf ( "2. Delete\n" ) ;
        printf ( "3. Update\n" ) ;
        printf ( "4. List\n" ) ;
        printf ( "0. Exit\n" ) ;

        printf ( "\nEnter choice: " ) ;
        scanf ( "%d", &choice ) ;

        switch ( choice ) /* take action based on choice */
        {
            case 1 :
                printf ( "\nEnter employee's number, name, sex and
```

```
        gross salary: " );
scanf ( "%d %s %c %f", &emp.empno, emp.name,
        &emp.sex, &emp.gs );
fwrite ( &emp, sz, 1, fp ); /* write new record to file */
break ;

case 2 :
    printf ( "\nEnter employee number: " );
    scanf ( "%d", &delno );
    flag = 1 ;

    fseek ( fp, 0L, SEEK_SET );
    while ( fread ( &emp, sz, 1, fp ) == 1 )
    {
        if ( emp.empno == delno )
        {
            emp.gs = flag = 0 ; /* employee deleted */

            fseek ( fp, -sz, SEEK_CUR );
            fwrite ( &emp, sz, 1, fp ); /* modify file */
            break ;
        }
    }

    if ( flag )
        puts ( "No such employee number exists.\n" );
    break ;

case 3 :
    printf ( "\nEnter employee number & gross salary: " );
    scanf ( "%d %f", &delno, &newgs );
    flag = 1 ;

    fseek ( fp, 0L, SEEK_SET );
    while ( fread ( &emp, sizeof ( emp ), 1, fp ) == 1 )
    {
        if ( emp.empno == delno )
        {
```

```

        flag = 0 ;
        emp.gs = newgs ;
        fseek ( fp, -sz, SEEK_CUR ) ;
        fwrite ( &emp, sz, 1, fp ) ;
        break ;
    }
}

if ( flag )
    puts ( "No such employee number exists.\n" ) ;
break ;

case 4 :
    fseek ( fp, 0L, SEEK_SET ) ; /* List records from
                                   beginning */
    while ( fread ( &emp, sizeof ( emp ), 1 ,fp ) == 1 )
        printf ( "%d %s %c %f\n",emp.empno,
                  emp.name,emp.sex,emp.gs ) ;
    break ;

case 0 :
    fclose ( fp ) ;
    exit ( 0 ) ;
    break ;
}

}

return 0 ;
}

```

- (n) Given a text file, write a program to create another text file deleting the words “a”, “the”, “an” and replacing each one of them with a blank space.

Program:

/ Create a new text file after replacing "a", "an" & "the" with a blank*

space from a given text file */

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

FILE *ft ;
int charcount ;
void newstr ( char *, char * ) ;

int main( )
{
    FILE *fs ;
    char str[ 80 ], source[ 67 ], target[ 67 ] ;
    char *apstr[ ] = { "a", "the", "an" } ;
    int i ;

    puts ( "Enter source file name: " ) ;
    gets ( source ) ;

    puts ( "Enter target file name: " ) ;
    gets ( target ) ;

    fs = fopen ( source, "r" ) ; /* read only mode for source file */

    if ( fs == NULL )
    {
        puts ( "Unable to open source file\n" ) ;
        exit ( 1 ) ;
    }

    ft = fopen ( target, "w+" ) ; /* write / modify mode for target file */

    if ( ft == NULL )
    {
        fclose ( fs ) ;
        puts ( "Unable to create target file\n" ) ;
        exit ( 2 ) ;
    }
}
```

```
while ( fgets ( str, 79, fs ) != NULL )
{
    newstr ( str, apstr[ 0 ] );

    for ( i = 1 ; i <= 2 ; i++ )
    {
        fseek ( ft, -charcount, SEEK_CUR );
        fgets ( str, charcount, ft );

        fseek ( ft, -charcount, SEEK_CUR );
        newstr ( str, apstr[ i ] );
    }
}

fclose ( fs );
fclose ( ft );

return 0 ;
}

void newstr ( char *p, char *t )
{
    int len = strlen ( t );
    charcount = 0 ;

    while ( *p )
    {
        if ( ( !strcmp ( p, t, len ) && *( p - 1 ) == ' ' ) && *( p + len )
            == ' ' || *( p + len ) == '\n' ) || ( !strcmp ( p, t, len ) && (
            charcount == 0 ) && *( p + len ) == ' ' || *( p + len ) == '\n' ) )
        {
            fputc ( ' ', ft );
            p = p + strlen ( t ) - 1 ;
        }
        else
            fputc ( *p, ft );

        p++ ;
    }
}
```

```
        charcount++;  
    }  
  
    charcount++;  
}
```

- (o) You are given a data file EMPLOYEE.DAT with the following record structure:

```
struct employee  
{  
    int empno ;  
    char name[ 30 ] ;  
    int basic, grade ;  
};
```

Every employee has a unique **empno** and there are supposed to be no gaps between employee numbers. Records are entered into the data file in ascending order of employee number. It is intended to check whether there are missing employee numbers. Write a program to read the data file records sequentially and display the list of missing employee numbers.

Program:

```
/* find missing employee numbers from a given file */  
#include <stdio.h>  
  
int main( )  
{  
    struct employee  
    {  
        int empno ;  
        char name[ 30 ] ;  
        int basic, grade ;  
    };  
    struct employee emp ;
```

```
FILE *fp ;
int count = 1 ;

fp = fopen ( "EMPLOYEE.DAT", "r" ) ; /* Read only mode */

if ( fp == NULL )
{
    puts ( "Unable to open file\n" ) ;
    exit ( 1 ) ;
}

printf ( "The list of missing employee numbers:\n" ) ;

while ( fread ( &emp, sizeof ( struct employee ), 1, fp ) == 1 )
{
    if ( emp.empno != count )
    {
        for ( ; count < emp.empno ; count++ )
            printf ( "%d\n", count ) ;
    }
    count++ ;
}

fclose ( fp ) ;
return 0 ;
}

/* The "Employee.dat" file can be created using the following code */
/* Pl. ensure that your directory is set correctly */

# include <stdio.h>

int main( )
{
    FILE *mf ;

    struct employee
    {
```



```
int empno ;
char name[ 30 ] ;
int basic, grade ;
};

struct employee emp ;
int i, msz = sizeof ( struct employee ) ;

system ( "cls" ) ;

mf = fopen ( "employee.dat", "w" ) ;

if ( mf == NULL )
{
    puts ( "Unable to open file\n" ) ;
    exit ( 1 ) ;
}

printf ( "\nEnter Values : " ) ;
for ( i = 0 ; i <= 5 ; i++ )
{
    printf ( "\nEmployee No.: " ) ;
    scanf ( "%d", &emp.empno ) ;
    fflush ( stdin ) ;
    printf ( "\nName: " ) ;
    scanf ( "%s", &emp.name ) ;
    fflush ( stdin ) ;
    printf ( "\nBasic: " ) ;
    scanf ( "%d", &emp.basic ) ;
    printf ( "\nGrade: " ) ;
    scanf ( "%d", &emp.grade ) ;
    fflush ( stdin ) ;
    fwrite ( &emp, msz, 1, mf ) ;
}

fcloseall ( ) ;
printf ( "\nFile employee.dat has been created\n" ) ;
return 0 ;
```

```
}
```

(p) Write a program to carry out the following operations:

- Read a text file “TRIAL.TXT” consisting of a maximum of 50 lines of text, each line with a maximum of 80 characters.
- Count and display the number of words contained in the file.
- Display the total number of four letter words in the text file.

Assume that the end of a word may be a space, comma or a full-stop followed by one or more spaces or a newline character.

Program:

```
/* count number of words in a file */
# include <stdio.h>

int main( )
{
    FILE *fp ;
    char str[ 80 ] ;
    int words = 0, f_l_words = 0, i ;

    fp = fopen ( "TRIAL.TXT", "r" ) ;

    if ( fp == NULL )
    {
        puts ( "Unable to open file\n" ) ;
        exit ( 1 ) ;
    }

    while ( ( fgets ( str, 79, fp ) ) != NULL )
    {
```

```

for ( i = 1 ; str[ i ] != '\0' ; i++ )
{
    if ( str[ i ] == '.' || ( str[ i ] == '\n' && str[ i - 1 ] != '.' ) ||
        str[ i ] == ',' || ( str[ i ] == ' ' && str[ i - 1 ] != ',' &&
            str[ i - 1 ] != '.' ) )
        words++ ;

    if ( i < 74 )
    {
        if ( str[ i ] == ' ' && ( str[ i + 5 ] == ' ' ||
            str[ i + 5 ] == '\n' || str[ i + 5 ] == '.' ||
            str[ i + 5 ] == ',' ) )
            f_l_words++ ;

        if ( i == 1 && ( str[ 4 ] == ' ' || str[ 4 ] == ',' || str[ 4 ] == '.')
            && ( str[ 1 ] != ' ' && str[ 1 ] != ',' && str[ 1 ] != '.' )
            && ( str[ 2 ] != ' ' && str[ 2 ] != ',' && str[ 2 ] != '.' ) )
            f_l_words++ ;
    }
}

printf ( "The total number of words are %d\n", words ) ;
printf ( "The number of four letter words are %d\n", f_l_words ) ;

fclose ( fp ) ;
return 0 ;
}

```

- (q) Write a program to read a list of words from a file, sort the words in alphabetical order and display them one word per line. Also give the total number of words in the list. Output format should be:

Total Number of words in the list is _____

Alphabetical listing of words is:

Assume the end of the list is indicated by **ZZZZZZ** and there are maximum in 25 words in the Text file.

Program:

```
/* Read, sort and display list of words from a file */

#include <stdio.h>

int main( )
{
    FILE *fp ;
    char *str[ 25 ], words[ 25 ][ 25 ], *t ;
    int i, j, n ;

    fp = fopen ( "trial.TXT", "r" ) ;

    if ( fp == NULL )
    {
        puts ( "Unable to open file\n" ) ;
        exit ( 1 ) ;
    }

    for ( n = 0 ; n <= 24 ; n++ )
        str[ n ] = words[ n ] ;

    for ( n = 0 ; fgets ( str[ n ], 24, fp ) != NULL ; n++ )
        ;

    for ( i = 0 ; i <= n - 2 ; i++ )
    {
        for ( j = i + 1 ; j <= n - 1 ; j++ )
        {
            if ( strcmp ( str[ i ], str[ j ] ) > 0 )
            {
                t = str[ i ] ;
                str[ i ] = str[ j ] ;
                str[ j ] = t ;
            }
        }
    }

    for ( i = 0 ; i < n ; i++ )
        printf ( "%s\n", str[ i ] ) ;
}
```

```

        str[j] = t;
    }
}

printf ( "Total Number of words in the list is %d\n", n );
printf ( "Alphabetical listing of words\n" );

for ( i = 0 ; i <= n - 1 ; i++ )
    printf ( "%s\n", str[i] );

fclose ( fp );
return 0 ;
}

```

(r) Write a program to carry out the following:

- (a) Read a text file 'INPUT.TXT'
- (b) Print each word in reverse order

Example:

Input: INDIA IS MY COUNTRY

Output: AIDNI SI YM YRTNUOC

Assume that maximum word length is 10 characters and words are separated by newline/blank characters.

Program:

```

/* Read a text file and print each word in reverse order */

#include <stdio.h>

int main( )
{
    FILE *fp ;
    char str[ 11 ], ch ;
    int i = 0 ;

```

```
fp = fopen ( "INPUT.TXT", "r" );

if ( fp == NULL )
{
    puts ( "Unable to open file\n" );
    exit ( 1 );
}

while ( ( ch = getc ( fp ) ) != EOF )
{
    if ( ch == '\n' || ch == ' ' )
    {
        str[ i ] = '\0';
        strrev ( str );
        printf ( "%s ", str );
        i = 0;
    }
    else
        str[ i++ ] = ch ;
}

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

- (s) Write a C program to read a large text file 'NOTES.TXT' and print it on the printer in cut-sheets, introducing page breaks at the end of every 50 lines and a pause message on the screen at the end of every page for the user to change the paper.

Program:

```
/* Reading a disk file and printing on cut sheets */
# include <stdio.h>

int main( )
```

```
{
    FILE *fp ;
    /* counters for characters per line & number of lines per page */
    int charcount = 0, linecount = 0 ;
    char ch ;

    fp = fopen ( "NOTES.TXT", "r" ) ; /* read only mode */

    if ( fp == NULL )
    {
        puts ( "Unable to open file\n" ) ;
        exit ( 1 ) ;
    }

    /* read until end of file */
    while ( ( ch = fgetc ( fp ) ) != EOF )
    {
        if ( ch == '\t' )
            charcount += 3 ; /* add 3 characters for a tab */

        charcount++ ;

        if ( ch == '\n' || charcount >= 80 )
        {
            linecount++ ; /* increment line counter after 80
                           characters */
            charcount = 0 ; /* reset character counter */
        }

        if ( linecount == 49 ) /* print 49 lines per page */
        {
            puts ( "Insert another page, then press any key..." ) ;
            linecount = 0 ; /* reset line counter */
        }

        fputc ( ch, stdout ) ; /* send to printer */
    }
}
```

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


CHAPTER

TWENTY

More Issues In Input/Output

[A] Answer the following:

(a) How will you use the following program to

- Copy the contents of one file into another.
- Create a new file and add some text to it.
- Display the contents of an existing file.

```
# include <stdio.h>
int main( )
{
    char ch, str[ 10 ] ;
    while ( ( ch = getc ( stdin ) ) != -1 )
        putc ( ch, stdout ) ;
    return 0 ;
}
```

Answer:

```
# include <stdio.h>
int main( )
{
```

```
char ch, str[ 10 ], tar[ 10 ] ;

/* fp1: pointer to the source file */
/* ft: pointer to the target file */
FILE *fp1, *ft ;

/* copy the content of one file into another */
while ( ( ch = getc ( fp1 ) ) != EOF )
    putc ( ch, ft ) ;

/* creat a new file and add some text to it */
while ( ( ch = getc ( stdin ) ) != EOF )
    putc ( ch, ft ) ;

/* display the content of the existing file */
while ( ( ch = getc ( fp1 ) ) != EOF )
    putc ( ch, stdout ) ;

return 0 ;
}
```

(b) State True or False:

1. We can send arguments at command line even if we define **main()** function without parameters.

Answer: False

2. To use standard file pointers we don't need to open the file using **fopen()**.

Answer: True

3. The zeroth element of the **argv** array is always the name of the executable file.

Answer: False

(c) Point out the errors, if any, in the following program:

```
#include <stdio.h>
int main ( int ac, char ( *) av[ ] )
{
    printf ( "%d\n", ac );
    printf ( "%s\n", av[ 0 ] );
    return 0 ;
}
```

Declaration of **av** should be **char *av[]**.

[B] Attempt the following:

- (a) Write a program using command line arguments to search for a word in a file and replace it with the specified word. The usage of the program is shown below.

C> change <old word> <new word> <filename>

Program:

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

FILE *fs, *ft ;
int newstr ( char *, char *, char * ) ;

int main ( int argc, char *argv[ ] )
{
    char str[ 80 ] ;
    char *arg1, *arg2, *fname ;
    int newstr ( char *s, char *t, char *n ) ;
    int c = 0 ;

    /* check if proper no of arguments are passed */
    if ( argc != 4 )
    {
        puts ( "Improper number of arguments\n" ) ;
        exit ( 1 ) ;
    }
}
```

```
    }

    fs = fopen ( argv[ 3 ], "r+" );
    ft = fopen ( "temp.c", "w" );

    if ( fs == NULL )
    {
        puts ( "Unable to open the file\n" );
        exit ( 2 );
    }

    if ( strlen ( argv[ 1 ] ) > strlen ( argv[ 2 ] ) )
    {
        printf ( "Number of characters in strings mismatch\n" );
        exit ( 3 );
    }

    arg1 = argv[ 1 ];
    arg2 = argv[ 2 ];
    fname = argv[ 3 ];

    while ( fgets ( str, 79, fs ) != NULL )
        c = newstr ( str, arg1, arg2 );

    fclose ( fs );
    fclose ( ft );
    printf ( "%d replacements done\n", c );
    remove ( fname );
    rename ( "temp.c", fname );

    return 0 ;
}

int newstr ( char *pt, char *t, char *n )
{
    static int count = 0 ;
    char *p, *temp, *news, *p1 ;
```

```
/* find the entered string in our array */
p1 = pt ;
do
{
    p = strstr ( p1, t ) ;

    if ( p == NULL )
        break ;

    /* copy the remaining string */
    news = p + strlen ( t ) ;
    strcpy ( temp, news ) ;

    /* replace the old string */
    strcpy ( p, n ) ;

    /* finally append the remaining part */
    strcat ( p, temp ) ;
    count++ ;

    p1 = p1 + strlen ( t ) ;
} while ( 1 ) ;

fputs ( pt, ft ) ;
return count ;
}
```

- (b) Write a program that can be used at command prompt as a calculating utility. The usage of the program is shown below.

C> calc <switch> <n> <m>

Where, **n** and **m** are two integer operands. **switch** can be any one of the arithmetic or comparison operators. If arithmetic operator is supplied, the output should be the result of the operation. If comparison operator is supplied then the output should be **True** or **False**.

Program:

```
/* To perform the given arithmetic operation on the two integers */
#include <stdio.h>
#include <string.h>

int main ( int argc, char *argv[ ] )
{
    int i, first, second, result ;

    /* arithmetic and logical operators */
    char *str[7] = { "+", "-", "*", "/", "%", "&&", "||" };

    /* check if proper no of arguments are passed */
    if ( argc != 4 )
    {
        puts ( "Improper number of arguments\n" );
        exit ( 1 );
    }

    /* check if the entered operator is valid */
    for ( i = 0 ; i <= 6 ; i++ )
    {
        if ( strcmp ( argv[ 2 ], str[ i ] ) == 0 )
            break ;
    }

    if ( i == 7 )
    {
        printf ( "\nNot a valid operator\n" );
        exit ( 2 );
    }

    first = atoi ( argv[ 1 ] );
    second = atoi ( argv[ 3 ] );
    printf ( "\nResult of the operation is:\n" );

    switch ( i )
```

```
{
    case 0 :
        result = first + second ;
        printf ( "%d\n", result ) ;
        break ;
    case 1 :
        result = first - second ;
        printf ( "%d\n", result ) ;
        break ;
    case 2 :
        result = first * second ;
        printf ( "%d\n", result ) ;
        break ;
    case 3 :
        result = first / second ;
        printf ( "%d\n", result ) ;
        break ;
    case 4 :
        result = first % second ;
        printf ( "%d\n", result ) ;
        break ;
    case 5 :
        result = first && second ;
        result == 0 ? printf ( "False\n" ) : printf ( "True\n" ) ;
        break ;
    case 6 :
        result = first || second ;
        result == 0 ? printf ( "False\n" ) : printf ( "True\n" ) ;
        break ;
}

return 0 ;
}
```


CHAPTER

TWENTY ONE

Operations On Bits

[A] Answer the following:

- (a) The information about colors is to be stored in bits of a **char** variable called **color**. The bit number 0 to 6, each represent 7 colors of a rainbow, i.e. bit 0 represents violet, 1 represents indigo, and so on. Write a program that asks the user to enter a number and based on this number it reports which colors in the rainbow do the number represents.

Program:

```
/* To determine the color */
# include <stdio.h>

int main( )
{
    int color ;

    printf ( "\nEnter any number: " ) ;
    scanf ( "%d", &color ) ;

    printf ( "Colors represented are:\n" ) ;

    if ( ( color & 1 ) == 1 ) /* bit 0 */
        printf ( "Violet\n" ) ;
```

```

    if ( ( color & 2 ) == 2 ) /* bit 1 */
        printf ( "Indigo\n" );
    if ( ( color & 4 ) == 4 ) /* bit 2 */
        printf ( "Blue\n" );
    if ( ( color & 8 ) == 8 ) /* bit 3 */
        printf ( "Green\n" );
    if ( ( color & 16 ) == 16 ) /* bit 4 */
        printf ( "Yellow\n" );
    if ( ( color & 32 ) == 32 ) /* bit 5 */
        printf ( "Orange\n" );
    if ( ( color & 64 ) == 64 ) /* bit 6 */
        printf ( "Red\n" );

    return 0 ;
}

```

- (b) A company planning to launch a new newspaper in market conducts a survey. The various parameters considered in the survey were, the economic status (upper, middle, and lower class) the languages readers prefer (English, Hindi, Regional language) and category of paper (daily, supplement, tabloid). Write a program, which reads data of 10 respondents through keyboard, and stores the information in an array of integers. The bit-wise information to be stored in an integer is given below:

Bit Number	Information
0	Upper class
1	Middle class
2	Lower class
3	English
4	Hindi
5	Regional Language
6	Daily
7	Supplement
8	Tabloid

At the end give the statistical data for number of persons who read English daily, number of Upper class people who read Tabloid and number of Regional Language readers.

Program:

```
/* To implement a survey */
#include <stdio.h>

int main( )
{
    int status, lang, cat ;
    int data[ 10 ] ;
    int i ;
    int rl = 0, ut = 0, eng = 0 ;

    /* initialize the array with 0 */
    for ( i = 0 ; i < 10 ; i++ )
        data[ i ] = 0 ;

    for ( i = 0 ; i < 10 ; i++ )
    {
        printf ( "\nEnter the economic status: upper/middle/lower class:
                ( 0/1/2 ): " ) ;
        scanf ( "%d", &status ) ;

        /* check the status */
        switch ( status )
        {
            case 0 :
                data[ i ] = data[ i ] | 1 ;
                break ;
            case 1 :
                data[ i ] = data[ i ] | 2 ;
                break ;
            case 2 :
                data[ i ] = data[ i ] | 4 ;
                break ;
```

```
        default :
            printf ( "Improper data\n" );
            exit ( 1 );
    }

    printf ( "\nEnter the language preferred: English/Hindi/Regional:
            ( 0/1/2 ): " );
    scanf ( "%d", &lang );

    /* check the language */
    switch ( lang )
    {
        case 0 :
            data[ i ] = data[ i ] | 8 ;
            break ;
        case 1 :
            data[ i ] = data[ i ] | 16 ;
            break ;
        case 2 :
            data[ i ] = data[ i ] | 32 ;
            break ;
        default :
            printf ( "Improper data\n" );
            exit ( 2 );
    }

    printf ( "\nEnter the category of paper: daily/supplement/tabloid:
            ( 0/1/2 ): " );
    scanf ( "%d", &cat );

    /* check the category */
    switch ( cat )
    {
        case 0 :
            data[ i ] = data[ i ] | 64 ;
            break ;
        case 1 :
            data[ i ] = data[ i ] | 128 ;
```

```
        break ;
    case 2 :
        data[ i ] = data[ i ] | 256 ;
        break ;
    default :
        printf ( "Improper data\n" ) ;
        exit ( 2 ) ;
    }
}

/* people who read English Daily*/
for ( i = 0 ; i < 10 ; i++ )
{
    if ( ( ( ( data[ i ] & 8 ) == 8 ) && ( ( data[ i ] & 64 ) == 64 ) ) )
        eng++ ;
}

/* upper class people who read tabloid */
for ( i = 0 ; i < 10 ; i++ )
{
    if ( ( ( ( data[ i ] & 1 ) == 1 ) && ( ( data[ i ] & 256 ) == 256 ) ) )
        ut++ ;
}

/* number of regional language readers */
for ( i = 0 ; i < 10 ; i++ )
{
    if ( ( data[ i ] & 32 ) == 32 )
        rl++ ;
}

printf ( "Number of people who read English Daily: %d\n", eng ) ;
printf ( "Number of Upper class people reading Tabloid: %d\n", ut ) ;
printf ( "Number Regional language readers: %d\n", rl ) ;

return 0 ;
}
```

- (c) In an inter-college competition, various sports like cricket, basketball, football, hockey, lawn tennis, table tennis, carom and chess are played between different colleges. The information regarding the games won by a particular college is stored in bit numbers 0, 1, 2, 3, 4, 5, 6, 7 and 8 respectively of an integer variable called **game**. The college that wins in 5 or more than 5 games is awarded the Champion of Champions trophy. If a number representing the bit pattern mentioned above is entered through the keyboard then write a program to find out whether the college won the Champion of the Champions trophy or not, along with the names of the games won by the college.

Program:

```
/* Determine the games won */
#include <stdio.h>

int main( )
{
    int game ;
    int cnt, count = 0 ;

    printf ( "\nEnter any number: " );
    scanf ( "%d", &game );

    /* count the no of games won */
    for ( cnt = 1 ; cnt <= 256 ; cnt *= 2 )
    {
        if ( ( game & cnt ) == cnt ) /* bits 0 to 7 */
            count++ ;
    }
    printf ( "Matches won by the college are: %d\n", count );

    if ( count >= 5 )
    {
        printf ( "College has won Champion of Champions trophy\n" );
    }
}
```

```
printf ( "The games won by the college are:\n" );

if ( ( game & 1 ) == 1 ) /* bit 0 */
    printf ( "Cricket\n" );
if ( ( game & 2 ) == 2 ) /* bit 1 */
    printf ( "Basketball\n" );
if ( ( game & 4 ) == 4 ) /* bit 2 */
    printf ( "Football\n" );
if ( ( game & 8 ) == 8 ) /* bit 3 */
    printf ( "Hockey\n" );
if ( ( game & 16 ) == 16 ) /* bit 4 */
    printf ( "Lawn tennis\n" );
if ( ( game & 32 ) == 32 ) /* bit 5 */
    printf ( "Table tennis\n" );
if ( ( game & 64 ) == 64 ) /* bit 6 */
    printf ( "Carom\n" );
if ( ( game & 128 ) == 128 ) /* bit 7 */
    printf ( "Chess\n" );
}

return 0 ;
}
```

- (d) An animal could be a canine (dog, wolf, fox, etc.), a feline (cat, lynx, jaguar, etc.), a cetacean (whale, narwhal, etc.) or a marsupial (koala, wombat, etc.). The information whether a particular animal is canine, feline, cetacean, or marsupial is stored in bit number 0, 1, 2 and 3 respectively of a integer variable called **type**. Bit number 4 of the variable **type** stores the information about whether the animal is Carnivore or Herbivore.

For the following animal, complete the program to determine whether the animal is a herbivore or a carnivore. Also determine whether the animal is a canine, feline, cetacean or a marsupial.

```
struct animal
```



```
{
    char name[ 30 ];
    int type ;
}
struct animal a = { "OCELOT", 18 } ;
```

Program:

```
/* Determine the type of animal */

# include <stdio.h>

int main( )
{
    struct animal
    {
        char name[ 30 ];
        int type ;
    };
    static struct animal a = { "OCELOT", 18 } ;
    int ani ;

    printf ( "\nAnimal is:" ) ;
    ani = a.type ;
    if ( ( ani & 1 ) == 1 ) /* bit 0 */
        printf ( "Canine\n" ) ;
    if ( ( ani & 2 ) == 2 ) /* bit 1 */
        printf ( "Feline\n" ) ;
    if ( ( ani & 4 ) == 4 ) /* bit 2 */
        printf ( "Catacean\n" ) ;
    if ( ( ani & 8 ) == 8 ) /* bit 3 */
        printf ( "Marsupial\n" ) ;

    printf ( "\nAnimal is also a\n" ) ;
    if ( ( ani & 16 ) == 16 ) /* bit 4 */
        printf ( "Carnivore\n" ) ;
    else
        printf ( "Herbivore\n" ) ;
```

```
    return 0 ;
}
```

- (e) The time field in a structure is 2 bytes long. Distribution of different bits which account for hours, minutes and seconds is given below. Write a function which would receive the two-byte time and return to the calling function, the hours, minutes and seconds.

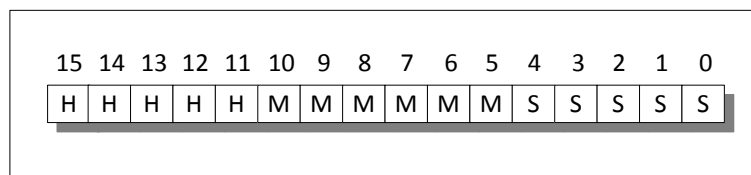


Figure 21.11

Program:

```
/* Program to display hour, minute, and seconds */
#include <stdio.h>

void times ( unsigned int time );

unsigned short int  hours, minutes, seconds ; /* Global variables */

int main( )
{
    int time ;

    puts ( "Enter any  number ( less than 24446 ): " );
    scanf ( "%u", &time );

    times ( time );
    printf ( "For Time = %u\n", time );
    printf ( "Hours = %u\n", hours );
    printf ( "Minutes = %u\n", minutes );
    printf ( "Seconds = %u\n", seconds );
}
```

```

        return 0 ;
    }

    void times ( unsigned int time )
    {
        unsigned short int temp ;
        hours = time >> 11 ;
        temp = time << 5 ;
        minutes = temp >> 10 ;
        temp = time << 11 ;
        seconds = ( temp >> 11 ) * 2 ;
    }

```

- (f) In order to save disk space, information about student is stored in an integer variable. If bit number 0 is on then it indicates Ist year student, bit number 1 to 3 stores IInd year, IIIrd year and IVth year student respectively. Bits 4 to 7 store the stream Mechanical, Chemical, Electronics and IT. Rest of the bits store room number. Based on the given data, write a program that asks for the room number and displays the information about the student, if its data exists in the array. The contents of array are,

```
int data[ ] = { 273, 548, 786, 1096 } ;
```

Program:

```

/* Determine the year and branch */
#include <stdio.h>

int main( )
{
    int num ;
    int cnt, rno ;
    int data[ ] = { 273, 548, 786, 1096 } ;

```

```
printf ( "\nEnter the room number: " );
scanf ( "%d", &num );

/* check if the data matches */
for ( cnt = 0 ; cnt < 4 ; cnt++ )
{
    rno = ( data [ cnt ] >> 8 );
    if ( num == rno )
        break ;
}
if ( cnt == 4 )
{
    printf ( "No such data present\n" );
    exit ( 0 );
}

for ( cnt = 1 ; cnt <= 8 ; cnt *= 2 )
{
    if ( ( num & cnt ) == cnt ) /* bits 0 to 3 */
        break ;
}

/* determine the year */
switch ( cnt )
{
    case 1 :
        printf ( "The student is of First year\n" );
        break ;
    case 2 :
        printf ( "The student is of Second year\n" );
        break ;
    case 4 :
        printf ( "The student is of Third year\n" );
        break ;
    case 8 :
        printf ( "The student is of Fourth year\n" );
}
}
```

```
for ( cnt = 16 ; cnt <= 128 ; cnt *= 2 )
{
    if ( ( num & cnt ) == cnt ) /* bits 4 to 7 */
        break ;
}

/* determine the branch */
switch ( cnt )
{
    case 16 :
        printf ( "The student is of Mechanical branch\n" ) ;
        break ;
    case 32 :
        printf ( "The student is of Chemical branch\n" ) ;
        break ;
    case 64 :
        printf ( "The student is of Electronics branch\n" ) ;
        break ;
    case 128 :
        printf ( "The student is of IT branch\n" ) ;
}

return 0 ;
}
```

(g) What will be the output of the following program:

```
#include <stdio.h>
int main( )
{
    int i = 32, j = 65, k, l, m, n, o, p ;
    k = i | 35 ;
    l = ~k ;
    m = i & j ;
    n = j ^ 32 ;
    o = j << 2 ;
    p = i >> 5 ;
```

```
printf ( "k = %d l = %d m = %d\n", k, l, m );  
printf ( "n = %d o = %d p = %d\n", n, o, p );  
return 0 ;  
}
```

Program:

```
/* Output of bitwise operations */  
# include <stdio.h>  
  
int main( )  
{  
    int i = 32, j = 65, k ;  
  
    k = i | 35 ;  
    printf ( "k = %d\n", k ) ; /* k = 35 */  
    k = ~k ;  
    printf ( "k = %d\n", k ) ; /* k = -36 */  
  
    k = i & j ;  
    printf ( "k = %d\n", k ) ; /* k = 0 */  
  
    k = j ^ 32 ;  
    printf ( "k = %d\n", k ) ; /* k = 97 */  
  
    k = j << 2 ;  
    printf ( "k = %d\n", k ) ; /* k = 260 */  
  
    k = i >> 5 ;  
    printf ( "k = %d\n", k ) ; /* k = 1 */  
  
    return 0 ;  
}
```

[B] Answer the following:

- (a) What is hexadecimal equivalent of the following binary numbers:

```

0101 1010
11000011
1010101001110101
1111000001011010

```

Answer:

```

5A
C3
AA75
F05A

```

- (b) Rewrite the following expressions using bitwise compound assignment operators:

```

a = a | 3
a = a & 0x48
b = b ^ 0x22
c = c << 2
d = d >> 4

```

Answer:

```

a |= 3;
a &= 0x48;
b ^= 0x22;
c <<= 2;
d >>= 4;

```

- (c) Consider an unsigned integer in which rightmost bit is numbered as 0. Write a function **checkbits (x, p, n)** which returns true if all "n" bits starting from position "p" are turned on. For example, **checkbits (x, 4, 3)** will return true if bits 4, 3 and 2 are 1 in number x.

Program:

```

#include <stdio.h>

```

```
#include <math.h>

void showbits ( unsigned int ) ;
int checkbits ( unsigned int, int, int ) ;

int main( )
{
    unsigned int x = 0xF0FF ;
    int n, p ;
    int flag ;

    printf ( "Value of x = " ) ;
    showbits ( x ) ;
    printf ( "\n" ) ;

    printf ( "Enter position and number of bits:\n" ) ;
    scanf ( "%d %d", &p, &n ) ;

    flag = checkbits ( x, p, n ) ;

    if ( flag == 1 )
        printf ( "%d bits starting from pos %d are turned on\n", n, p ) ;
    else
        printf ( "%d bits starting from pos %d are turned off\n", n, p ) ;

    return 0 ;
}

void showbits ( unsigned int n )
{
    int i ;
    unsigned int j, k, andmask ;

    for ( i = 15 ; i >= 0 ; i-- )
    {
        j = i ;
        andmask = 1 << j ;
        k = n & andmask ;
```



```

        k == 0 ? printf ( "0" ) : printf ( "1" ) ;
    }
}

int checkbits ( unsigned int x, int p, int n )
{
    int i ;
    unsigned int res ;
    int no = 0 ;

    for ( i = 0 ; i < n ; i++ )
    {
        if ( ( ( x >> ( p - 1 ) ) & 1 ) != 1 )
            return 0 ;
        p-- ;
    }
    return 1 ;
}

```

- (d) Write a program to scan a 8-bit number into a variable and check whether its 3rd, 6th and 7th bit is on.

Program:

```

/* Program to check whether a 3rd, 6th and 7th bit of a number is on */
# include <stdio.h>

void showbits ( unsigned char ) ;

int main( )
{
    unsigned char num = 0x8C, j ;

    printf ( "\nValue of num = " ) ;
    showbits ( num ) ;
    printf ( "\n" ) ;
}

```

```
j = num & 0x08 ;

if ( j == 0 )
    printf ( "Its third bit is off\n" ) ;
else
    printf ( "Its third bit is on\n" ) ;

j = num & 0x40 ;

if ( j == 0 )
    printf ( "Its sixth bit is off\n" ) ;
else
    printf ( "Its sixth bit is on\n" ) ;

j = num & 0x80 ;

if ( j == 0 )
    printf ( "Its seventh bit is off\n" ) ;
else
    printf ( "Its seventh bit is on\n" ) ;

return 0 ;
}

void showbits ( unsigned char n )
{
    int i ;
    unsigned char j, k, andmask ;

    for ( i = 7 ; i >= 0 ; i-- )
    {
        j = i ;
        andmask = 1 << j ;
        k = n & andmask ;
        k == 0 ? printf ( "0" ) : printf ( "1" ) ;
    }
}
```

- (e) Write a program to receive an unsigned 16-bit integer and then exchange the contents of its two bytes using bitwise operators.

Program:

```
/* Program to exchange the contents of numbers two bytes */

# include <stdio.h>
void showbits ( unsigned int ) ;

int main( )
{
    unsigned int num = 0xF0F0, k = 0x0F0F ;

    printf ( "Value of num = " ) ;
    showbits ( num ) ;
    printf ( "\n" ) ;

    num = num ^ k ;
    k = k ^ num ;
    num = num ^ k ;

    printf ( "After exchanging the contents of numbers two bytes using
            bitwise operators the number is = " ) ;
    showbits ( num ) ;
    printf ( "\n" ) ;

    return 0 ;
}

void showbits ( unsigned int n )
{
    int i ;
    unsigned int j, k, andmask ;

    for ( i = 15 ; i >= 0 ; i-- )
```

```
    {  
        j = i;  
        andmask = 1 << j;  
        k = n & andmask;  
        k == 0 ? printf ( "0" ) : printf ( "1" );  
    }  
}
```

- (f) Write a program to receive a 8-bit number into a variable and then exchange its higher 4 bits with lower 4 bits.

Program:

```
/* Program to exchange a numbers higher 4 bits with lower 4 bits */  
#include <stdio.h>  
  
void showbits ( unsigned char );  
  
int main( )  
{  
    unsigned char num = 0xF0, j;  
  
    printf ( "\nValue of num = " );  
    showbits ( num );  
    printf ( "\n" );  
  
    j = num >> 4;  
  
    printf ( "After exchanging a numbers higher 4 bits with lower 4 bits  
            the number is = \n" );  
    showbits ( j );  
    printf ( "\n" );  
  
    return 0;  
}  
  
void showbits ( unsigned char n )
```

```
{
    int i;
    unsigned char j, k, andmask;

    for ( i = 7 ; i >= 0 ; i-- )
    {
        j = i;
        andmask = 1 << j;
        k = n & andmask;
        k == 0 ? printf ( "0" ) : printf ( "1" );
    }
}
```

- (g) Write a program to receive a 8-bit number into a variable and then set its odd bits to 1.

```
# include <stdio.h>
# define _BV(x) ( 1 << x )

void showbits ( unsigned char n );
int main( )
{
    unsigned char a, b, c;

    printf ( "Enter a number\n" );
    scanf ( "%d", &a );

    b = _BV(1) | _BV(3) | _BV(5) | _BV(7);
    a = a | b;
    showbits ( a );
    printf ( "\n" );
}

void showbits ( unsigned char n )
{
    int i;
    unsigned char j, k, andmask;
```

```
for ( i = 7 ; i >= 0 ; i-- )
{
    j = i ;
    andmask = 1 << j ;
    k = n & andmask ;
    k == 0 ? printf ( "0" ) : printf ( "1" ) ;
}
}
```

- (h) Write a program to receive a 8-bit number into a variable and then check if its 3rd and 5th bit are on. If these bits are found to be on then put them off.

```
# include <stdio.h>
# define _BV(x) ( 1 << x )

void showbits ( unsigned char n ) ;
int main ( )
{
    unsigned char a, b, c ;

    printf ( "Enter a number\n" ) ;
    scanf ( "%d", &a ) ;

    b = _BV(3) | _BV(5) ;

    if ( ( a & b ) == b )
    {
        printf ( "3rd and 5th bit are on\n" ) ;
        c = ~ ( _BV( 3 ) | _BV( 5 ) ) ;
        showbits ( c ) ;
        printf ( "\n" ) ;
        a = a & c ;
        showbits ( a ) ;
        printf ( "\n" ) ;
    }
}
```

```
}  
  
void showbits ( unsigned char n )  
{  
    int i;  
    unsigned char j, k, andmask;  
  
    for ( i = 7 ; i >= 0 ; i-- )  
    {  
        j = i;  
        andmask = 1 << j;  
        k = n & andmask;  
        k == 0 ? printf ( "0" ) : printf ( "1" );  
    }  
}
```

- (i) Write a program to receive a 8-bit number into a variable and then check if its 3rd and 5th bit are off. If these bits are found to be off then put them on.

```
#include <stdio.h>  
#define _BV(x) ( 1 << x )  
  
void showbits ( unsigned char n );  
int main( )  
{  
    unsigned char a, b;  
  
    printf ( "Enter a number\n" );  
    scanf ( "%x", &a );  
  
    printf ( "a = " );  
    showbits ( a );  
    printf ( "\n" );  
  
    b = _BV(3) | _BV(5);
```

```

    if ( ( a & b ) == 0 )
    {
        printf ( "3rd and 5th bit are off\n" );
        a = a | b ;
        printf ( "a = " );
        showbits ( a );
        printf ( "\n" );
    }
}

void showbits ( unsigned char n )
{
    int i ;
    unsigned char j, k, andmask ;

    for ( i = 7 ; i >= 0 ; i-- )
    {
        j = i ;
        andmask = 1 << j ;
        k = n & andmask ;
        k == 0 ? printf ( "0" ) : printf ( "1" ) ;
    }
}

```

- (j) Rewrite the **showbits()** function used in this chapter using the **_BV** macro.

```

#define _BV(x) ( 1 << x )

void showbits ( unsigned char n )
{
    int i ;
    unsigned char j, k ;

    for ( i = 7 ; i >= 0 ; i-- )
    {
        j = i ;

```



```
        k = n & _BV(j);  
        k == 0 ? printf("0") : printf("1");  
    }  
}
```

CHAPTER

TWENTY TWO

Miscellaneous Features

[A] What will be the output of the following programs:

(a) #include <stdio.h>

```
int main( )
{
    enum status { pass, fail, atkt };
    enum status stud1, stud2, stud3 ;
    stud1 = pass ;
    stud2 = fail ;
    stud3 = atkt ;
    printf ( "%d %d %d\n", stud1, stud2, stud3 ) ;
    return 0 ;
}
```

Output:

0 1 2

(b) #include <stdio.h>

```
int main( )
{
    printf ( "%f\n", ( float ) ( ( int ) 3.5 / 2 ) ) ;
    return 0 ;
}
```

Output:

1.000000

```
(c) #include <stdio.h>
int main( )
{
    float i, j;
    i = ( float ) 3 / 2 ;
    j = i * 3 ;
    printf ( "%d\n", ( int ) j ) ;
    return 0 ;
}
```

Output:

4

[B] Point out the error, if any, in the following programs:

```
(a) #include <stdio.h>
int main( )
{
    typedef struct patient
    {
        char name[ 20 ] ;
        int age ;
        int systolic_bp ;
        int diastolic_bp ;
    } ptt ;
    ptt p1 = { "anil", 23, 110, 220 } ;
    printf ( "%s %d\n", p1.name, p1.age ) ;
    printf ( "%d %d\n", p1.systolic_bp, p1.diastolic_bp ) ;
    return 0 ;
}
```

No Error

```
(b) #include <stdio.h>
void show( ) ;
```

```
int main( )
{
    void ( *s )( );
    s = show ;
    ( *s )( );
    s( );
    return 0 ;
}
void show( )
{
    printf ( "don't show off. It won't pay in the long run\n" );
}
```

No Error

```
(c) #include <stdio.h>
void show ( int, float );
int main( )
{
    void ( *s )( int, float );
    s = show ;
    ( *s )( 10, 3.14 );
    return 0 ;
}
void show ( int i, float f )
{
    printf ( "%d %f\n", i, f );
}
```

Error. Type Mismatch in declaration and definition of **show()**. While defining **show()**, return type must be specified as **void**.

[C] Attempt the following:

- (a) Create an array of four function pointers. Each pointer should point to a different function. Each of these functions should

receive two integers and return a float. Using a loop call each of these functions using the addresses present in the array.

Program:

```
/* To create an array of function pointers */  
#include <stdio.h>
```

```
float fun1 ( int, int );  
float fun2 ( int, int );  
float fun3 ( int, int );  
float fun4 ( int, int );
```

```
float fun1 ( int i, int j )  
{  
    printf ( "\n\n fun1 %d %d", i, j );  
    return ( float )( i / j );  
}
```

```
float fun2 ( int i, int j )  
{  
    printf ( "\n\n fun2 %d %d", i, j );  
    return ( float )( i / j );  
}
```

```
float fun3 ( int i, int j )  
{  
    printf ( "\n\n fun3 %d %d", i, j );  
    return ( float )( i / j );  
}
```

```
float fun4 ( int i, int j )  
{  
    printf ( "\n\n fun4 %d %d", i, j );  
    return ( float )( i / j );  
}
```

```
int main( )
{
    float ( *ptr[ 4 ] ) ( int, int );
    float f ;
    int i ;

    ptr [ 0 ] = fun1 ;
    ptr [ 1 ] = fun2 ;
    ptr [ 2 ] = fun3 ;
    ptr [ 3 ] = fun4 ;

    for ( i = 1 ; i < 4 ; i++ )
    {
        f = ( *ptr [ i - 1 ] ) ( 100, i ) ;
        printf ( "%f\n", f ) ;
    }

    return 0 ;
}
```

- (b) Write a function that receives variable number of arguments, where the arguments are the coordinates of a point. Based on the number of arguments received, the function should display type of shape like a point, line, triangle, etc. that can be drawn.

Program:

```
/* To recognise type of shape */
# include <stdio.h>

void shape ( int, ... ) ;

int main( )
{
    shape ( 2, 5, 10 ) ;
    shape ( 4, 1, 1, 10, 1 ) ;
    shape ( 6, 15, 10, 5, 25, 20, 25 ) ;
}
```

```
        return 0 ;
    }

    void shape ( int tot_pt, ... )
    {
        switch ( tot_pt )
        {
            case 2 :
                printf ( "Type of shape is point\n" ) ;
                break ;

            case 4 :
                printf ( "Type of shape is line\n" ) ;
                break ;

            case 6 :
                printf ( "Type of shape is triangle\n" ) ;
                break ;
        }
    }
}
```

- (c) Write a program, which stores information about a date in a structure containing three members—day, month and year. Using bit fields the day number should get stored in first 5 bits of day, the month number in 4 bits of month and year in 12 bits of year. Write a program to read date of joining of 10 employees and display them in ascending order of year.

Program:

```
/* To store joining dates using bit fields */
#include <stdio.h>

int main( )
{
    struct date
    {
        unsigned day : 5 ;
```

```
        unsigned month : 4 ;
        unsigned year : 12 ;
    };
    struct date dt[ 10 ], temp ;
    int i, j, d, m, y ;

    printf ( "Enter joining dates (dd-mm-yyyy) of 10 employees\n" ) ;

    for ( i = 0 ; i < 10 ; i++ )
    {
        scanf ( "%d %d %d", &d, &m, &y ) ;

        if ( ( ( d < 1 ) || ( d > 31 ) ) ||
            ( ( m < 1 ) || ( m > 12 ) ) ||
            ( ( y < 1900 ) || ( y > 2004 ) ) )
        {
            printf ( "Invalid date, enter new date\n" ) ;
            i-- ;
            continue ;
        }

        dt[ i ].day = d ;
        dt[ i ].month = m ;
        dt[ i ].year = y ;
    }

    for ( i = 0 ; i < 9 ; i++ )
    {
        for ( j = i + 1 ; j < 10 ; j++ )
        {
            if ( dt[ j ].year < dt[ i ].year )
            {
                temp = dt[ i ] ;
                dt[ i ] = dt[ j ] ;
                dt[ j ] = temp ;
            }
        }
    }
}
```



```
    for ( i = 0 ; i < 10 ; i++ )
        printf ( "%d %d %d\n", dt[ i ].day, dt[ i ].month, dt[ i ].year ) ;

    return 0 ;
}
```

- (d) Write a program to read and store information about insurance policy holder. The information contains details like gender, whether the holder is minor/major, policy name and duration of the policy. Make use of bit-fields to store this information.

Program:

```
/* To store information about insurance policy holder */

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

int main( )
{
    struct policy_holder
    {
        unsigned gender : 1 ; // 0-Male, 1-Female
        unsigned status : 1 ; // 0-Minor, 1-Major
        char name[ 20 ] ;
        unsigned dr : 5 ;
    } ;
    struct policy_holder h ;
    int g, s, d ;
    char n[ 20 ] ;

    printf ( "\nEnter gender (0-Male, 1-Female) of the policy holder: " ) ;
    scanf ( "%d", &g ) ;

    printf ( "\nEnter status (0-Minor, 1-Major) of the policy holder: " ) ;
    scanf ( "%d", &s ) ;
```

```
printf ( "\nEnter name of the policy holder: " );
scanf ( "%s", n );

printf ( "\nEnter duration (1 to 25 yrs) of the policy: " );
scanf ( "%d", &d );

h.gender = g ;
h.status = s ;
strcpy ( h.name, n );
h.dr = d ;

printf ( "Name: %s\n", h.name );
printf ( "Gender: %s\n", h.gender == 0 ? "Male" : "Female" );
printf ( "Status: %s\n", h.status == 0 ? "Minor" : "Major" );
printf ( "Duration %d\n", h.dr );

return 0 ;
}
```


CHAPTER

TWENTY THREE

C Under Linux

[A] State True or False:

- (a) We can modify the kernel of Linux OS.

Answer: True

- (b) All distributions of Linux contain the same collection of applications, libraries and installation scripts.

Answer: False

- (c) Basic scheduling unit in Linux is a file.

Answer: False

- (d) **execl()** library function can be used to create a new child process.

Answer: False

- (e) The scheduler process is the father of all processes.

Answer: False

- (f) A family of **fork()** and **exec()** functions are available, each doing basically the same job but with minor variations.

Answer: True

- (g) **fork()** completely duplicates the code and data of the parent process into the child process.

Answer: False

- (h) **fork()** overwrites the image (code and data) of the calling process.

Answer: False

- (i) **fork()** is called twice but returns once.

Answer: False

- (j) Every zombie process is essentially an orphan process.

Answer: False

- (k) Every orphan process is essentially a zombie process.

Answer: False

- (l) All registered signals must have a separate signal handler.

Answer: False

- (m) Blocked signals are ignored by a process.

Answer: False

- (n) Only one signal can be blocked at a time.

Answer: False

- (o) Blocked signals are ignored once the signals are unblocked.

Answer: False

- (p) If our signal handler gets called, the default signal handler still gets called.

Answer: False

- (q) **gtk_main()** function makes use of a loop to prevent the termination of the program.

Answer: True

- (r) Multiple signals can be registered at a time using a single call to **signal()** function.

Answer: False

- (s) The **sigprocmask()** function can block as well as unblock signals.

Answer: True

[B] Answer the following:

- (a) If a program contains four calls to **fork()** one after the other, how many total processes would get created?

Answer:

Sixteen processes would get created.

- (b) What is the difference between a zombie process and an orphan process?

Answer:

If child process terminates before parent and parent does not query the exit code of a terminated child process, then the entry of the child process continues to exist in the Process Table. Such a child process is said to be a 'Zombie'. If the parent terminates without querying the zombie child process is treated as an 'Orphan' process. Also when the parent process terminates and child processes are still running, then such child process are called as 'Orphan' process.

- (c) Write a program that prints the command-line arguments that it receives. What would be the output of the program if the command-line argument is *?

Answer:

```
/* To print command line arguments */
#include <unistd.h>

int main ( int argc, char *argv [ ] )
{
    int i ;
    for ( i = 0 ; i < argc ; i++ )
        printf ( "%s\n", argv [ i ] ) ;

    return 0 ;
}
```

If the command line argument is * then it will print all the non-hidden files in the current working directory.

- (d) What purpose do the functions **getpid()** and **getppid()** serve?

Answer:

The **getpid()** function returns the process-id of the calling process. The **getppid()** function returns the process-id of the parent of the calling process. There is no such function as **getpppid()**!

- (e) Rewrite the program in the section ‘Zombies and Orphans’ in this chapter by replacing the **while** loop with a call to the **sleep()** function. Do you observe any change in the output of the program?

Answer:

```
/* To compare loop and sleep( ) */
# include <unistd.h>
# include <sys/types.h>

int main( )
{
    unsigned int i = 0 ;
    int pid, status ;

    pid = fork( ) ;

    if ( pid == 0 )
    {
        //while ( i < 4294967295U )
        //    i++ ;

        sleep ( 4 ) ;
        printf ( "The child is now terminating\n" ) ;
    }
    else
    {
        waitpid ( pid, &status, 0 ) ;

        if ( status )
```



```
        printf ( "Parent : Child terminated normally\n " );
    else
        printf ( "Parent : Child terminated abnormally\n " );
    }

    return 0 ;
}
```

- (f) How does **waitpid()** prevent creation of Zombie or Orphan processes?

Answer:

The **waitpid()** function will make the parent process wait till the execution of the child process is not completed. It ensures that the child process never becomes 'Orphan'. Once the child process terminates, **waitpid()** queries its exit-code from the process table and returns back to the parent. As a result of this querying, the entry for the child process is removed from the process table. So child process never becomes a 'zombie'.

- (g) How does the Linux OS know if we have registered a signal or not?

Answer:

Linux operating system maintains a structure that keeps track of signals registered/blocked by a process. This structure is maintained on a per process basis. Linux operating system looks up this structure from time to time. When a new signal is registered it is entered into this structure.

- (h) What happens when we register a handler for a signal?

Answer:

Whenever a new signal handler is registered, the operating system gets the address of the signal handler and the signal

code. Next the operating system updates the structure that keeps track of registered signals for the calling process. This structure is updated so as to make a new entry for the signal code and mark it registered.

- (i) Write a program to verify whether **SIGSTOP** and **SIGKILL** signals are un-catchable signals.

Program:

```
/* To verify SIGSTOP and SIGKILL signals are un-catchable signals */
#include <signal.h>

void intHandler ( int signum )
{
    printf ( "SIGINT recd inside sighandler\n" );
}

void killHandler ( int signum )
{
    printf ( "SIGKILL is not catchable\n" );
}

void stopHandler ( int signum )
{
    printf ( "SIGSTOP is not catchable\n" );
}

int main( )
{
    signal ( SIGINT, intHandler );
    signal ( SIGSTOP, stopHandler );
    signal ( SIGKILL, killHandler );

    while ( 1 )
        printf ( "Program Running\n" );

    return 0 ;
}
```

```
}
```

- (j) Write a program to handle the **SIGINT** and **SIGTERM** signals. From inside the handler for **SIGINT** signal write an infinite loop to print the message 'Processing Signal'. Run the program and make use of Ctrl + C more than once. Run the program once again and press Ctrl + C once. Then use the **kill** command. What are your observations?

Program:

```
/* To handle SIGINT and SIGTERM signals */
#include <signal.h>

void intHandler ( int signum )
{
    while ( 1 )
        printf ( "Processing Signal... \n" );
}

void termHandler ( int signum )
{
    printf ( "SIGTERM recd inside sighandler\n" );
}

void contHandler ( int signum )
{
    printf ( "SIGCONT recd inside sighandler\n" );
}

int main( )
{
    signal ( SIGINT, ( void* ) intHandler );
    signal ( SIGCONT, ( void* ) contHandler );
    signal ( SIGTERM, ( void* ) termHandler );

    while ( 1 )
        printf ( "Program Running\n" );
}
```

```
    return 0 ;  
}
```

- (k) Write a program that blocks the **SIGTERM** signal during execution of the **SIGINT** signal.

Program:

```
/* To block SIGTERM signal during execution of SIGINT signal */
```

```
# include <signal.h>  
# include <unistd.h>  
# include <sys/types.h>  
# include <stdio.h>  
  
void intHandler ( int signum )  
{  
    sigset_t block ;  
    char buffer[ 10 ] = "\0" ;  
  
    sigemptyset ( &block ) ;  
    sigaddset ( &block , SIGTERM ) ;  
  
    sigprocmask ( SIG_BLOCK , &block , NULL ) ;  
  
    while ( strcmp ( buffer , "n" ) != 0 )  
    {  
        printf ( "Enter a string: " ) ;  
        gets ( buffer ) ;  
        puts ( buffer ) ;  
    }  
  
    sigprocmask ( SIG_UNBLOCK , &block , NULL ) ;  
}  
  
void termHandler ( int signum )  
{
```

```
        printf ( "SIGTERM recd inside sighandler\n" );
    }

    int main( )
    {
        signal ( SIGINT, intHandler );
        signal ( SIGTERM, termHandler );
        while ( 1 )
            printf ( "Program Running\n" );

        return 0 ;
    }
```

CHAPTER

TWENTY FOUR

Periodic Tests

Periodic Test I

[A] Fill in the blanks: [5 Marks, 1 Mark each]

- (1) The expression **i++** is same as ++i.
- (2) Real / float / double type of values cannot be checked using **switch-case**.
- (3) Every instruction in a C program must end with a ;.
- (4) The size of an **int** data type is 4 bytes.
- (5) Statements written in do-while loop get executed at least once even if the condition is false.

[B] State True or False: [5 Marks, 1 Mark each]

- (1) The statement **for (; ;)** is a valid statement. **True**
- (2) The **else** clause in an **if - else if - else** statement goes to work if all the **ifs** fail. **True**
- (3) The **^** operator is used for performing exponentiation operations in C. **False**
- (4) C allows only one variable on the left hand side of **=** operator. **True**
- (5) Conditional operators cannot be nested. **False**

[C] What would be the output of the following programs:

[5 Marks, 1 Mark each]

- (a) 5 5 6
- (b) 65 A
- (c) 2 1
- (d) 21 525
- (e) 0 1

[D] Point out the error, if any, in the following programs:

[5 Marks, 1 Mark each]

- (a) Use == instead of =
- (b) 'then' : undeclared identifier
- (c) Syntax error: missing ';' before ':'.
- (d) No Error.
- (e) Error: The variable 'c' is being used without being initialized.

[E] Attempt the following: [20 Marks, 5 Marks each]

- (1) Write a program to calculate the sum of the following series:

$$1! 2! + 2! 3! + 3! 4! + 4! 5! + \dots + 9! 10!$$

```
#include <stdio.h>
int main( )
{
    int i, j, prod1, prod2, term, s ;

    s = 0 ;
    for ( i = 1 ; i <= 3 ; i++ )
    {
        prod1 = 1 ;
        for ( j = 1 ; j <= i ; j++ )
            prod1 = prod1 * j ;

        prod2 = prod1 * j ;
        term = prod1 * prod2 ;

        s = s + term ;
    }

    printf ( "sum of series=%f\n", s ) ;
    return 0 ;
}
```


- (2) Write a program to enter the numbers till the user wants and at the end it should display the count of positive, negative and zeros entered.

```
#include <stdio.h>
int main( )
{
    int neg, pos, zero, n ;

    char ch = 'y' ;
    while ( ch == 'y' || ch == 'Y' )
    {
        printf ( "Enter a number: \n" ) ;
        scanf ( "%d", &n ) ;

        if ( n > 0 )
            pos++ ;
        if ( n < 0 )
            neg++ ;
        if ( n == 0 )
            zero++ ;

        printf ( "Do you want to continue y/n" ) ;
        fflush ( stdin ) ;
        scanf ( "%c", &ch ) ;
    }

    printf ( "Positive = %d\n", pos ) ;
    printf ( "Negative = %d\n", neg ) ;
    printf ( "Zeros = %d\n", zero ) ;

    return 0 ;
}
```

- (3) Write a program to find the range of a set of numbers that are input through the keyboard. Range is the difference between the smallest and biggest number in the list.

```
#include<stdio.h>
int main( )
{
    int n, no, flag, small, big ;

    flag = 0 ;

    printf ( "Enter the number of elements in the range:\n" ) ;
    scanf ( "%d", &n ) ;

    while ( n > 0 )
    {
        printf ( "Enter a number:\n" ) ;
        scanf ( "%d", &no ) ;

        if ( flag == 0 )
        {
            small = big = no ;
            flag = 1 ;
        }
        else
        {
            if ( no > big )
                big = no ;
            if ( no < small )
                small = no ;
        }
        n-- ;
    }
    return 0 ;
}
```

- (4) If three integers are entered through the keyboard, write a program to determine whether they form a Pythagorean triplet or not.

```
#include<stdio.h>
int main( )
{
    int i, j, k ;

    printf ( "Enter three integers: \n" ) ;
    scanf ( "%d%d%d", &i, &j, &k ) ;

    if ( ( i * i + j * j == k * k ) || ( j * j + k * k == i * i ) ||
        ( k * k + i * i == j * j ) )
        printf ( "Numbers form pythagorian triplet \n" ) ;
    else
        printf ( "Numbers do not form pythagorian triplet \n" ) ;

    return 0 ;
}
```

Periodic Test II

[A] Fill in the blanks: [5 Marks, 1 Mark each]

- (1) system () function is used to clear the screen.
- (2) Pointers are variables, which hold addresses of other variables.
- (3) & is called an 'address of' operator.
- (4) The preprocessor directive that is used to give convenient names to difficult formulae is called macro expansion.
- (5) For a call by reference we should pass addresses of variables to the called function.

[B] State True or False: [5 Marks, 1 Mark each]

- (1) A function can return more than one value at a time. **False**
- (2) A fresh set of variables are created every time a function gets called. **True**
- (3) All types of pointers are 4 bytes long. **True**
- (4) Any function can be made a recursive function. **False**
- (5) The correct build order is Preprocessing – Compilation – Assembling – Linking. **True**

[C] Answer the following: [10 Marks, 2 Marks each]

- (1) Why are addresses of functions stored on the stack?

So that it would be possible to return to the same place from where the function was called, once the called function's execution is over.

- (2) How do we decide whether a variable should be passed by value or by reference?

If we want that the passed variable's value should not change in the function being called use a call by value.

If we want that the passed variable's value should change in the function being called use a call by reference.

- (3) Size of a pointer is not dependent on whose address is stored in it. Justify.

A pointer contains address. Any address is 4 byte long. So it does not matter, whose address is held in a pointer, the pointer remains 4 bytes long.

- (4) At times there may be holes in a structure? Why do they exist? How can they be avoided?

In many OSs it is easier to access an entity if it placed at an address which is a multiple of 4. So while creating a structure variable in memory, each structure element is placed at an address that is a multiple of 4. This leads to creation of holes in memory. They can be avoided using a `#pragma pack` preprocessor directive.

- (5) A recursive call should always be subjected to an **if**. Why? Explain with an example.

If the recursive call is not subjected to an **if**, the function would fall in an infinite loop.

```
void fun( )
{
    static int count = 0 ;

    count++ ;
    if ( count <= 5 )
    {
        printf ( "%d\n", count ) ;
```

```
        fun( ) ;
    }
    else
        return ;
}
```

[D] Attempt the following: [20 Marks, 5 Marks each]

- (1) Define a function that receives 4 integers and returns sum, product and average of these integers.

```
#include <stdio.h>

void calc ( int *, int *, float * ) ;
int main( )
{
    int sum, prod ;
    float avg ;

    calc ( &sum, &prod, &avg ) ;
    printf ( "%d %d %f\n", sum, prod, avg ) ;

    return 0 ;
}

void calc ( int *sum, int *prod, float *avg )
{
    int n1, n2, n3, n4 ;

    printf ( "\n Enter four numbers : " ) ;
    scanf ( "%d%d%d%d", &n1, &n2, &n3, &n4 ) ;

    *sum = n1 + n2 + n3 + n4 ;
    *prod = n1 * n2 * n3 * n4 ;
    *avg = *sum / 4.0f ;
}
```

- (2) Write a recursive function which prints the prime factors of the number that it receives when called from **main()** .

```
#include <stdio.h>
void factor ( int ) ;
int main )
{
    int num ;

    printf ( "\nEnter the number :\n " ) ;
    scanf ( "%d", &num ) ;
    printf ( "\nPrime Factors are : " ) ;
    factor ( num ) ;

    return 0 ;
}

void factor ( int n )
{
    static int i = 2 ;

    if ( i <= n )
    {
        If ( n % i == 0 )
        {
            printf ( "%d ", i ) ;
            n = n / i ;
        }
        else
            i++ ;

        factor ( n ) ;
    }
    return ;
}
```

- (3) Write macros for calculating area of circle, circumference of circle, volume of a cone and volume of sphere.

```
#include <stdio.h>
#define PI 3.14f
#define ACI(r) (PI * r * r)
#define CCI(r) (2 * PI * r)
#define VCO(r) ((1.0f / 3) * PI * r * r * r)
#define VCYL(r) ((4.0f / 3) * PI * r * r * r)

int main()
{
    float r, a_ci, c_ci, v_co, v_cyl;

    printf ( "\n Enter the value of r :\n" );
    scanf ( "%f", &r );

    a_ci = ACI ( r );
    c_ci = CCI ( r );
    printf ( "\nArea of circle : %f", a_ci );
    printf ( "\nCircumference of circle : %f", c_ci );

    v_co = VCO ( r );
    v_cyl = VCYL ( r );
    printf ( "\n Volume of cone : %f", v_co );
    printf ( "\n Volume of cylinder : %f", v_cyl );

    return 0 ;
}
```

- (4) Write a program that prints sizes of all types of chars, ints and reals.

```
#include <stdio.h>
int main()
{
    char ch ;
```



```
    unsigned char dh ;

    printf ( "character = %d\n", sizeof ( ch ) ) ;
    printf ( "unsigned character = %d\n", sizeof ( dh ) ) ;

    short int a ;
    short unsigned int b ;
    int c ;
    long int d ;
    long unsigned int e ;

    printf ( "short signed integer = %d\n", sizeof ( a ) ) ;
    printf ( "short unsigned integer = %d\n", sizeof ( b ) ) ;
    printf ( "integer = %d\n", sizeof ( c ) ) ;
    printf ( "long signed integer = %d\n", sizeof ( d ) ) ;
    printf ( "long unsigned integer = %d\n", sizeof ( e ) ) ;

    float f ;
    double g ;
    long double h ;

    printf ( "float = %d\n", sizeof ( f ) ) ;
    printf ( "double = %d\n", sizeof ( g ) ) ;
    printf ( "long double = %d\n", sizeof ( h ) ) ;

    return 0 ;
}
```

Periodic Test III

[A] Fill in the blanks: [5 Marks, 1 Mark each]

- (1) Mentioning name of the array yields base address of the array.
- (2) C permits us to exceed lower and upper bounds of an array.
- (3) Size of an array is sum of sizes of individual elements of an array.
- (4) Array elements are always counted from zero onwards.
- (5) A structure is usually a collection of dissimilar elements.

[B] State True or False: [5 Marks, 1 Mark each]

- (1) If the array is big its elements may get stored in non-adjacent locations. **False**
- (2) All strings end with a '\0'. **True**
- (3) Using **#pragma pack** you can control the layout of structure elements in memory. **True**
- (4) Elements of 2D array are stored in the form of rows and columns in memory. **False**
- (5) 3D array is a collection of several 1D arrays. **False**

[C] Answer the following: [10 Marks, 2 Marks each]

- (1) What is likely to happen if the bounds of an array are exceeded?

If bounds of an array while reading nothing will go wrong. However, if bounds are exceed while writing to an array, something important that is already present beyond the bounds would get overwritten. Sometimes this may even hang the program. If the bounds of array are exceeded the

compiler does not report an error “Subscript out of range”. Bounds checking is always programmers responsibility

- (2) When you prefer a structure over an array to store similar elements? Explain with an example.

A structure is preferred over an array when a set of similar elements are to be returned from a function, because on attempting to return an array only its base address would get returned.

For example, if we are to return a complex number containing a real part and imaginary part (both floats) it is more convenient to put them into a structure rather than in an array.

- (3) What is the limitation of an array of pointers to strings? How can it be overcome?

An array of pointers to strings is not very convenient if we are to receive strings into this array by reading them from keyboard. It can be overcome by first allocating space for strings using **malloc ()** and then storing the addresses of strings into the array of pointers.

- (4) In a two-dimensional array **a[4][4]**, why do expressions **a** and ***a** give base address?

a is supposed to give base address because **a**, the name of the array, acts as a pointer to the 0th element of the array. A 2D array is a collection of several 1D arrays. So when we use ***a**, we are referring to the 0th 1D array. And referring to 1D array always yields its base address, hence ***a** also gives the base address.

- (5) How can we receive multi-word strings as input using **scanf()** and using **gets()** ?

```
char str[ 30 ] ;
```

```
scanf ( "%[ ^\n ]s", str ) ;  
gets ( str ) ;
```

[D] Attempt the following: [20 Marks, 5 Marks each]

- (1) Write a function that receives as parameters, a 1D array, its size and an integer and returns number of times the integer occurs in the array.

```
#include <stdio.h>  
int countnum ( int*, int, int ) ;  
  
int main( )  
{  
    int arr[ 100 ], size, num, i, count ;  
  
    printf ( "Enter the size of array:\n" ) ;  
    scanf ( "%d", &size ) ;  
  
    printf ( "Enter the elements of an array:\n" ) ;  
    for ( i = 0 ; i < size ; i++ )  
        scanf ( "%d", &arr[ i ] ) ;  
  
    printf ( "Enter the number you want to count:\n" ) ;  
    scanf ( "%d", &num ) ;  
  
    count = countnum ( arr, size, num ) ;  
  
    printf ( "count = %d", count ) ;  
    return 0 ;  
}  
  
int countnum ( int *a, int sz, int n )  
{  
    int j, cnt = 0 ;  
  
    for ( j = 0 ; j < sz ; j++ )
```

```
    {  
        if ( *a == n )  
            cnt++ ;  
  
        a++ ;  
    }  
  
    return cnt ;  
}
```

- (2) Create an array of pointers containing names of 10 cities. Write a program that sorts the cities in reverse alphabetical order and prints this reversed list.

```
#include<iostream>  
using namespace std ;  
int main( )  
{  
    char *cities[ ] = {  
        "Nagpur",  
        "Kanpur",  
        "Delhi",  
        "Sikandarabad",  
        "Akola",  
        "Ghatanji",  
        "Jabalpur",  
        "Ziri",  
        "Shegaon",  
        "Bombay"  
    } ;  
  
    char *t ;  
    int i, j ;  
  
    for ( i = 0 ; i < 9 ; i++ )  
    {  
        for ( j = i + 1 ; j < 10 ; j++ )  
        {
```

```

        if ( strcmp ( city[ i ], city[ j ] ) < 0 )
        {
            t = city[ i ];
            city[ i ] = city[ j ];
            city[ j ] = t;
        }
    }

    for ( i = 0 ; i < 10 ; i++ )
        printf ( "%s\n", city[ i ] );

    return 0 ;
}

```

- (3) Declare a structure called student containing his name, age and address. Create and initialize three structure variables. Define a function to which these variables are passed. The function should convert the names into uppercase. Print the resultant structure variables.

```

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

void upper ( struct stud* );
struct stud
{
    char name[ 20 ];
    int age ;
    char addr[ 40 ];
};

struct stud s1 = { "akshay", 20, "Ravinagar" } ;
struct stud s2 = { "shubham", 21, "Civil Lines" } ;
struct stud s3 = { "nilesh", 22, "Khamla" } ;

int main( )
{

```

```
    upper ( &s1 );
    upper ( &s2 );
    upper ( &s3 );

    return 0 ;

}

void upper ( struct stud *s )
{
    printf ( "Before conversion:\n" );
    printf ( "%s %d %s\n", s->name, s->age, s->addr );
    strupr ( s->name );
    printf ( "After conversion:\n" );
    printf ( "%s %d %s\n", s->name, s->age, s->addr );
}
```

- (4) Write a program that checks and reports whether sum of elements in the i^{th} row of a 5 x 5 array is equal to sum of elements in i^{th} column.

```
#include <stdio.h>
int main( )
{
    int a[ 5 ][ 5 ], i, j, sumr = 0, sumc = 0 ;

    printf ( "enter the elements of array\n" );
    for ( i = 0 ; i < 5 ; i++ )
        for ( j = 0 ; j < 5 ; j++ )
            scanf ( "%d", &a[ i ][ j ] );

    printf ( "enter the row and column you want to check\n " );
    scanf ( "%d", &i );

    for ( j = 0 ; j < 5 ; j++ )
        sumr = sumr + a[ i - 1 ][ j ] ;
```

```
    for ( j = 0 ; j < 5 ; j++ )
        sumc = sumc + a[j][i - 1] ;

    if ( sumr == sumc )
        printf ( "the sums are equal" ) ;
    else
        printf ( "sums are not equal" ) ;

    return 0 ;
}
```


Periodic Test IV

[A] Fill in the blanks: [5 Marks, 1 Mark each]

- (1) `0xAABB | 0xBBAA` evaluates to `0xB BBB`.
- (2) The values of an **enum** are stored as integers.
- (3) Multiple signals can be registered at a time using calls to `signal()` function.
- (4) The `sigprocmask()` function can block as well as unblock signals.
- (5) The `~` operator is used to invert the bits in a byte.

[B] State True or False: [5 Marks, 1 Mark each]

- (1) To check whether a particular bit in a byte is on or off, the bitwise `|` operator is useful. **False**
- (2) It is possible to create a union of structures. **True**
- (3) The callback mechanism can be implemented using function pointers. **True**
- (4) `fork()` completely duplicates the code and data of the parent process into the child process. **False**
- (5) If our signal handler gets called, the default signal handler still gets called. **False**

[C] Answer the following: [10 Marks, 2 Marks each]

- (1) What is the utility of `<<`, `>>`, `&` and `|` bitwise operators?

`<<`, `>>` operators are useful to shift out bits in a number from left or right. `&` is used to check whether a bit is on or off, and to set a particular bit to 0. `|` operator is used to put on a bit.

- (2) Define the **BV** macro. How would the following expressions involving the **BV** macro be expanded by the preprocessor?

```
int a = BV ( 5 );
int b = ~ BV ( 5 );
```

```
#define BV( x ) 1 << x
int a = BV(5) is expanded to int a = 1 << 5
int b = ~ BV(5) is expanded to int b = ~ ( 1 << 5 )
```

- (3) What does the following expression signify?

```
long ( *p[ 3 ] ) ( int, float );
```

In this declaration **p** is an array of three function pointers, each pointer pointing to a function that receives an **int** and a **float** and returns a **long int**.

- (4) Suggest a suitable **printf()** that can be used to print the grocery items and their prices in the following format:

Tomato Sauce	: Rs. 225.50
Liril Soap	: Rs. 55.45
Pen Refill	: Rs. 8.95

```
printf ( "\n%25s:Rs. %8.2f\n", item, price );
```

- (5) When it is useful to make use of a union? What is the size of a union variable? How can the elements of a union variable be accessed?

We should use a union when we wish to access same memory locations in a multiple ways. Size of a union variable is size of the biggest element in the union. Elements of a union variable can be accessed using the **.** and **->** operators.

[D] Attempt the following: [20 Marks, 5 Marks each]

- (1) Write a program to multiply two integers using bitwise operators.

```
#include <stdio.h>
int main( )
{
    int a, b, result ;

    printf ( "\nEnter the numbers to be multiplied : " ) ;
    scanf ( "%d%d", &a, &b ) ;

    result = 0 ;
    while ( b != 0 )
    {
        if ( b & 1 )
            result = add ( result, a ) ;

        a <<= 1 ;
        b >>= 1 ;
    }
    printf ( "nResult:%d", result ) ;
}

int add ( int x, int y )
{
    while ( y != 0 )
    {
        int carry = x & y ;
        x = x ^ y ;
        y = carry << 1 ;
    }

    return x ;
}
```

- (2) Write a program to count number of words in a given text file.

```
#include<stdio.h>

int main( )
{
    char ch ; FILE *fp ;
    char fname[ 13 ] ;
    int count = 0 ;

    printf ( "Enter File name" ) ;
    gets ( fname ) ;

    fp = fopen ( fname, "r" ) ;
    while ( ( ch = getc ( fp ) ) != EOF )
    {
        if ( ch == ' ' )
            count++ ;
    }

    printf ( "No of words=%d", count + 1 ) ;
    fclose ( fp ) ;
}
```

- (3) Write a program that receives a set of numbers as command-line arguments and prints their average.

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

int main( int argc, char* argv[ ] )
{
    int sum, i, avg ;

    sum = 0 ;
    for ( i = 1 ; i <= argc ; i++ )
        sum = sum + atoi ( argv[ i ] ) ;
```

```
    avg = sum / argc ;  
    printf ( "Average=%f", avg ) ;  
  
    return 0 ;  
}
```

- (4) Write a program to check whether contents of the two files are same by comparing them on a byte-by-byte basis.

```
#include<stdio.h>  
#include<stdlib.h>  
  
int main( )  
{  
    char ch1,ch2 ;  
    FILE *fp,*fq ;  
    char fname1[ 13 ], fname2[ 13 ] ;  
  
    printf ( "Enter File1 name" ) ;  
    gets ( fname1 ) ;  
  
    printf ( "Enter File2 name" ) ;  
    gets ( fname2 ) ;  
  
    fp = fopen ( fname1, "rb" ) ;  
    fq = fopen ( fname2, "rb" ) ;  
  
    while ( 1 )  
    {  
        ch1 = getc ( fp ) ;  
        ch2 = getc ( fq ) ;  
  
        if ( ch1 != ch2 || ch1 == EOF && ch2 != EOF ||  
            ch1 != EOF && ch2 == EOF )  
        {  
            printf ( "File contents do not match" ) ;  
        }  
    }  
}
```

```
        exit ( 1 );
    }
}

printf ( "File contents match" );

fclose ( fp );
fclose ( fq );
}
```

