MODULE 1
INTRODUCTION

My Training Period: hours

Notes:
You can remove the `system("pause");` and its `stdlib.h` header file (if applicable) in the program examples. This code just to capture the console output for Borland C++ that was run through IDE. For Microsoft Visual C++/.Net, Borland Turbo or running the program using Borland command line, gcc etc. no need to include this code. For other compilers, please check their documentations.

Abilities

- Able to understand the brief history of the C/C++ language.
- Able to understand the C/C++ advantageous.
- Able to understand the basic program development cycle.
- Able to understand the basic structure of C/C++ program.
- Able to be familiar with writing codes, compiling and running a program.
- Able to recognize a portable `main()` function.
- Able to recognize the C and C++ standards: ANSI C/C++, ISO/IEC C/C++, POSIX and Single Unix specification.

1.1 Brief History

- C evolved from two previous languages, BCPL (Basic Combined Programming Language) and B. BCPL was developed in 1967 by Martin Richards as a language for writing operating systems software and compilers.
- Ken Thompson modeled many features in his language, B, after their counterparts in BCPL and used B to create early versions of UNIX operating system at bell Laboratories in 1970 on a DEC® PDP-7 computer.
- Both BCPL and B were typeless languages, that means the only data type is machine word and access to other kinds of objects is by special operators or function calls.
- In C, the fundamental data type includes characters, integers of several sizes and floating point numbers.
- The derived data types were created with pointers, arrays, structures, unions, functions and classes.
- The C language was evolved from B by Dennis Ritchie at Bell Laboratories and was originally implemented on a DEC PDP-11 computer in 1972.
- It was named C for new language.
- Initially, C used widely as the development language of the UNIX. Today, virtually all new major OS are written in C.
- C is hardware independent, so it is portable to most computers without or with little code modification.
- The rapid expansion of C over various types of computers led to many variations. These are similar but incompatible.
- So, a standard version of C was needed. In 1983, the X3J11 technical committee was created under the American National Standards Institute (ANSI) Committee on Computer and Information Processing (X3) to provide an ambiguous and machine-independent definition of the language and approved in 1989, called ANSI C.
- The document is referred to as ANSI/ISO 9899:1990.
- The second edition of Kernighan and Ritchie, published in 1988, reflects this version called ANSI C, then used worldwide. The more general ANSI then adopted by ISO/IEC, known as ISO/IEC C.
- Because C is a hardware-independent, applications written in C can be run with little or no modifications on a wide range of different computer systems.

1.2 Advantageous

- Powerful and flexible language - What can be achieved is only limited by your imagination. It is used for Operating System, compilers, parsers, interpreters, word processors, search engine and graphic programs.
- Portable programming language - C program written for one computer system (an IBM® PC, for example) can be compiled and run on another system (a DEC® VAX System perhaps with little or no modification).
- Is a language of less keyword - Handful of terms called keywords in which the language's functionality is built. A lot of keywords doesn't mean more powerful than C.

- Modular - Written in routines called functions and classes (C++), can be reused in other applications or programs.
- Preferred by professional programmers - So, a variety of C/C++ resources and helpful supports are widely available.
- Standardized – Many standards have been documented, maintained and updated for C and C++ as standard references for solving the portability and many other issues (please refer at the end of this tutorial).

1.3 Very Basic Program Development

- Computer program is designed to solve problem. Nowadays it makes ease a lot of our works.
- The simple steps to find a solution to problems are the same steps used to write a program and basically can be defined as follows:

    1. Define the problem.
    2. Devise a plan to solve it.
    3. Implement the plan.
    4. Test the result to see whether the problem is solved.

- When creating a program in C/C++:

    1. Determine the objective(s) of the program.
    2. Decide which method the program will use to solve the problem.
    3. Translate this method into a computer program using the `C/C++` language.
    4. Run and test the program.

- Typical steps might be followed in a program development is listed below:

No	Step	Description
1	**Using an editor to enter the source code**	From a simple text editor up to complex Integrate Development Environment (IDE). Examples: UNIX: `ed`, `ex`, `edit`, `emacs` and `vi`. Window OS: `notepad`, Microsoft Visual Studio/.Net®, Borland® `C++`, Borland Turbo® `C++`, `Borland Builder C++`, `BorlandX`. MSDOS®: `editor`. OS/2®: `E` or `EPM` editor.
2	**Using a compiler**	Computer can't understand the roman alphabets like English words. It only can understand machine language, `0`'s and `1`'s. The compiler perform this task, yields an object code (such as `.obj` or `.o`).
3	**Creating an executable file**	`C/C++` has **function** library that contains object code (codes that has been compiled) for predefined functions. These codes are ready to be used and can be called in the main program such as `printf()` function. They perform frequently needed tasks. Executable program can be run or executed. Before the executable program is created, a program called **linker** (to link other object and library files needed by the main program) performs a process called linking.
4	**Running/executing the program**	Running the executable file/image. If there is no error, that is your program! (a running program or a process).
5	**Debugging**	Debug, debug and debug, finding program bugs, this is in debug mode. **Alfa** version - May still contains bugs, pre-release version. **Beta** / RC, Release Candidate version - May still contains bugs, pre-release version. **Final** release – Release mode or release/Retail version (in reality, still have bugs`:o)`), but don't worry Patches and Service Packs will fix that.)
6	**Release/Distribution**	Creating the installation program for distribution.

- Typically, these basic steps are illustrated in figure 1.1 and quite a complete story can be found in Module W.

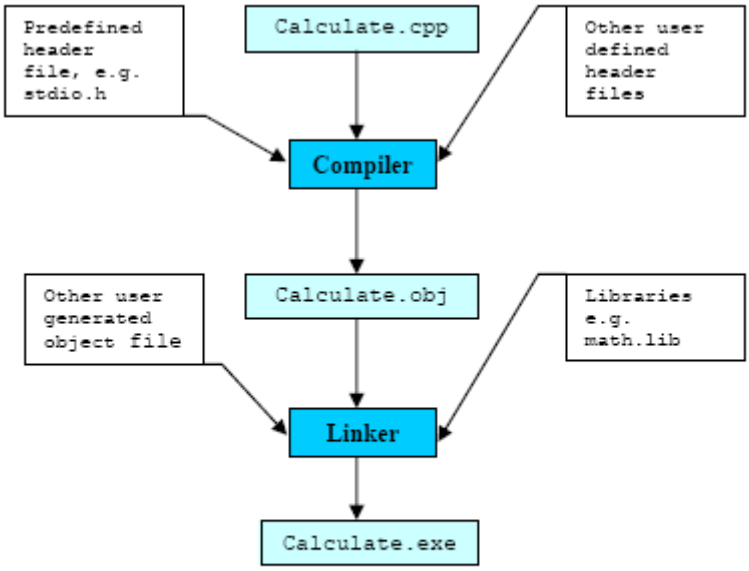
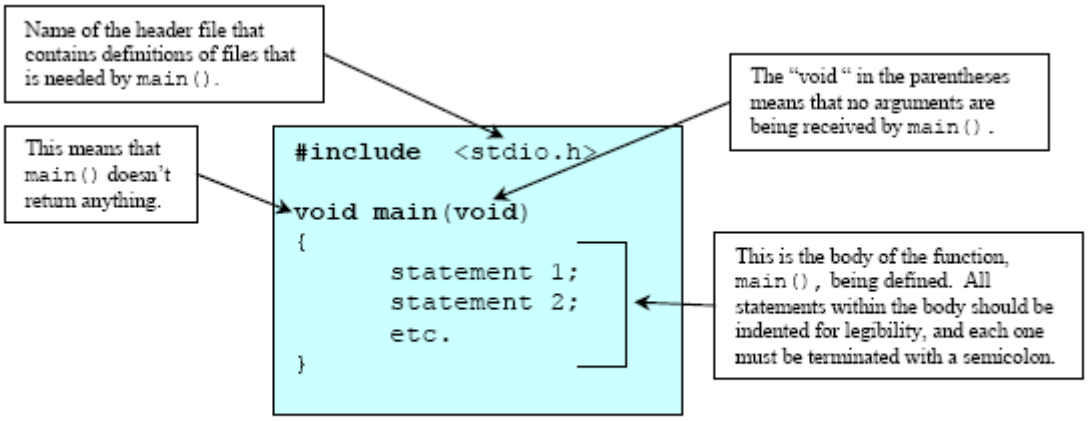


Figure 1.1: Typical program development steps



Program 1: Basic Structure of the C/C++ program

- Most of the editor used nowadays called Integrated Development Environment (IDE) that combines the process of compiling, linking, running, debugging, code validation, standard conformance and other functionalities in one environment such as Borland® C++ Builder and Microsoft Visual Studio®/.Net®.
- Keep in mind that there are other extensions for the C/C++ program other than the `.c`, `.cpp` and `.h`. You have to check your compiler documentations or you can read the story in Module W of this Tutorial.
- Bear in mind also the real program development actually consist of a team of programmers, system analysts, project leader etc.
- Individually, how many lines of codes that we can write huh? So be real when you use this Tutorial for learning C and C++ :o).

1.4 Object Oriented Programming

- C++ is a C superset was developed by Bjarne Stroustrup at Bell Laboratories (some call advanced C) and the ANSI C++ (ISO/IEC C++) standard version is also already available.
- C++ provides a number of features that spruce up the C language mainly in the object-oriented programming aspects and data type safety (which lack in C language). Though if you have studied the C++, you will find that the type safety of the C++ also not so safe :o) actually the secure codes depend on the programmers themselves (C++ discussed in Tutorial #3).
- Object are essentially reusable software components that model items in the real world.

- Using a modular, object-oriented design and implementation, can speed up the program development and make the same software development group, up to many times more productive than the conventional programming techniques.
- Then, the evolution of the C++ continues with the introduction of the Standard Template Library (STL). STL deal mainly with data structure processing and have introduced the using of templates. From procedural programming to object oriented programming, STL has introduced generic programming.
- Then we have **Common Language Runtime** (CLR) type of the programming language, something like Java (through the Java Virtual Machine – JVM) and the equivalent one from Microsoft is C#.

1.5 Sample of Simple Program Examples

- Let explore the basic structure of the C/C++ as shown in following section, before we proceed to the next Module. Don't worry about what the codes will do; just type or copy-paste and run the program.
- The program start with what is called preprocessor directive, `#include`.
- Then the main program start, with keyword `main()`, each program must have a `main()` function.
- All the coding is included in the body of the main program in the curly braces { } and } end the coding for the program.
- Try all the sample programs given. Be familiar with the writing codes, compiling, running and your IDE programming environment.

Program Examples – Warming up!

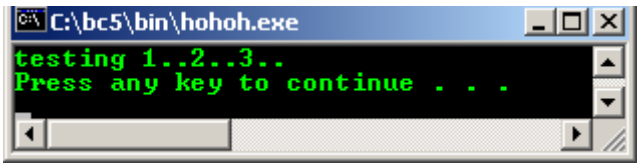
- Your task is to write the source code, compile and run. Notice that you only have to change some of the codes in the curly braces { } and adding or deleting the preprocessor directive to complete all the examples.
- Learn how to modify the program source code and re run the program. You will learn a lot more things!
- Please refer to the Kick Start: Using Compilers section, in order to write, compile and run your Win32 Console Mode Application program using Borland® or Microsoft Visual Studio®/.Net® product or whatever compiler you are familiar with.

Example #1

- For starting, first step we just create the program skeleton. Try to compile and run the simple program. Make sure there is no error. Notice the line of code that span on multiple lines. Keep it on one line.
- Don't worry about any syntax or standard violation; you will be prompted by your compiler through warnings and/or errors :o).
- Keep in mind that, typing the codes, is dealing with character set, laid out on your keyboard whether it is `ASCII`, `EBCDIC`, Unicode or proprietary character set :o).
- And C/C++ programs only deal with the characters, strings and mathematical expressions.

```
//The simplest program example
//preprocessor directives - header files
#include <iostream.h>
#include <stdlib.h>

//main() function with no argument
//and int return value…
int main( )
{
   cout<<"testing 1..2..3..\n";
   //system call 'pause'
   //command to wait temporarily for user action
   //by calling the system pause command
   //pause is Borland specific, for other compilers you may
   //discard this and its header <stdlib.h>
   system("pause");
   //return to Operating System, no error
   return 0;
}
```

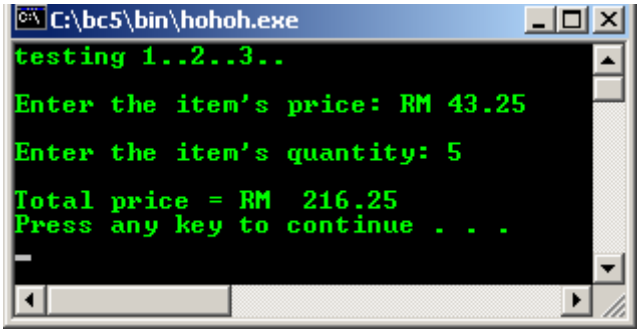
Output:



- Next step we add other lines of code. Recompile and rerun.

```
//Program to calculate total based on the
//given quantity and price
//preprocessor directives - header files
#include <iostream.h>
#include <stdlib.h>

//main() function with no argument
//and int return value…
int main(void)
{
      //variables declaration and
      //their respective the data types
      int   quantity;
      float price, total;

      cout<<"testing 1..2..3..\n";
      //standard output - read from user input
      cout<<"\nEnter the item's price: RM ";
      //standard input - store user's input at variable price
      cin>>price;
      cout<<"\nEnter the item's quantity: ";
      cin>>quantity;

      //multiply quantity and price
      //store the result at total…
      total = quantity * price;
      //Print the total value
      cout<<"\nTotal price = RM  "<<total<<endl;
      system("pause");
      return 0;
}
```

Output:

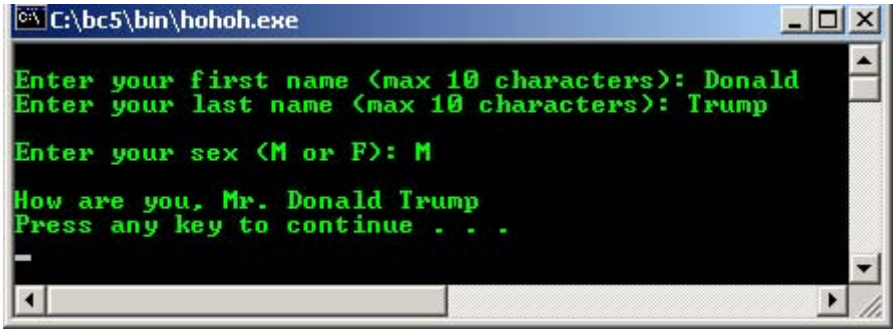


Example #2

```
//Simple greeting program using an array, pointer and selection
//you will learn more about array, pointer and selection later.
//The following #include … called preprocessor directive/header files.
//Means include the iostream.h file so that the compiler can find the
//definition for the cin and cout, then the cin and cout can function properly
#include <iostream.h>
//for system()
#include <stdlib.h>

int main(void)
{
    //normal variable and array with their respective data type
    char name[10], name1[10], sex;
    cout<<"\nEnter your first name (max 10 characters): ";
    cin>>name;

    cout<<"Enter your last name (max 10 characters): ";
    cin>>name1;
```

```
    cout<<"\nEnter your sex (M or F): ";
    cin>>sex;

    //test whether male or female
    if (sex == 'M')
    //array name without brackets is the pointer to the first
    //array's element
         cout<<"\nHow are you, Mr. "<<name<<" "<<name1<<endl;
    else
         cout<<"\nHow are you, Ms/Mrs  "<<name<<" "<<name1<<endl;
    system("pause");
    return 0;
}
```

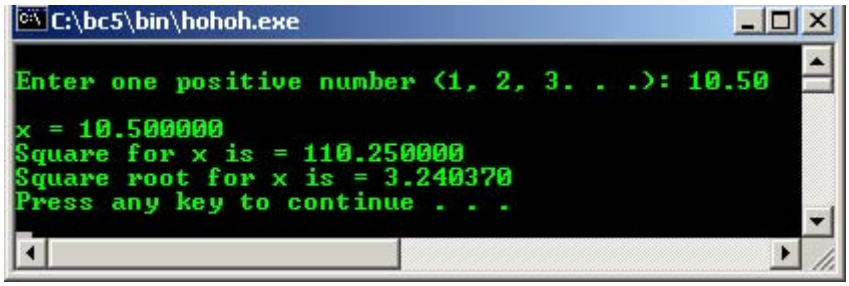
Output:



Example #3

```
//one line comment in program, C++
/*multiple lines comment, C - Program to display
square and square root for a given number*/
#include <math.h>   /*for sqrt() function*/
#include <stdio.h>
#include <stdlib.h>   //for system()

int main( )
{
    /*variable named x and floating-point data type*/
    float x;

    /*standard output*/
    printf("\nEnter one positive number (1, 2, 3. . .): ");
    /*standard input*/
    scanf("%f", &x);

    printf("\nx = %f ", x);
    printf("\nSquare for x is = %f", x * x);
    //sqrt() is the predefined function, defined in math.h
    printf("\nSquare root for x is = %f\n", sqrt(x));
    system("pause");
    return 0;
}
```

Output:

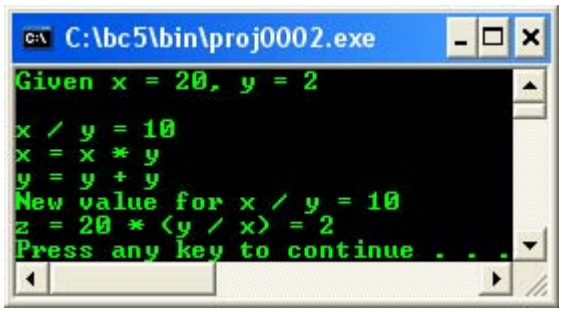


Example #4

```
/*Simple mathematics calculation*/
//header files…
#include <stdio.h>
```

```
#include <stdlib.h>

//main() function…
int main( )
{
    //variables declaration
    int  x, y, z;

       //variables initialization
       //assign 20 to variable x…
       //or put the value of 20 in memory location labeled by x
    x = 20;
    y = 2;

    printf("Given x = 20, y = 2\n");
    printf("\nx / y = %d", x / y);
       //do some calculation
    x = x * y;
    y = y + y;
    printf("\nx = x * y");
    printf("\ny = y + y");
    printf("\nNew value for x / y = %d", x / y);
    z = 20 * y / x;
    printf("\nz = 20 * (y / x) = %d\n", z);
   system("pause");
   return 0;
}
```

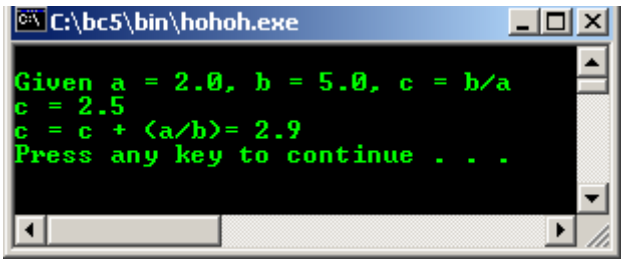
Output:



Example #5

```
//Another simple mathematics calculation
#include <iostream.h>
#include <stdlib.h>

int main(void)
{
    //variables declaration
    //variable names and type
    float a, b, c;

    //variables initialization
    a = 2.0;
    b = 5.0;
    c = b / a;

    cout<<"\nGiven a = 2.0, b = 5.0, c = b/a";
    cout<<"\nc = "<<c;
    c = c + (a/b);
    cout<<"\nc = c + (a/b) = "<<c<<endl;

    //call the predefined function
    //for Borland...
    system("pause");
   return 0;
}
```

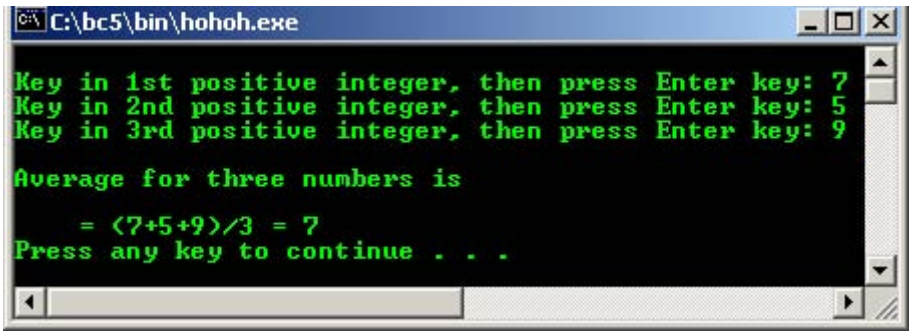
Output:



Example #6

```
//another mathematics calculation
#include <iostream.h>
#include <stdlib.h>

int main(void)
{
    float x, y, z;

    //Display for user data on standard output, screen
    cout<<"\nKey in 1st positive integer, then press Enter key: ";
    //Read the data from standard input, keyboard
    cin>>x;
    cout<<"Key in 2nd positive integer, then press Enter key: ";
    cin>>y;
    cout<<"Key in 3rd positive integer, then press Enter key: ";
    cin>>z;
    cout<<"\nAverage for three numbers is \n";
    cout<<"\n    = ("<<x<<"+"<<y<<"+"<<z<<")/3 = "<<(x+y+z)/3<<"\n";
    system("pause");
     return 0;
}
```

Output:

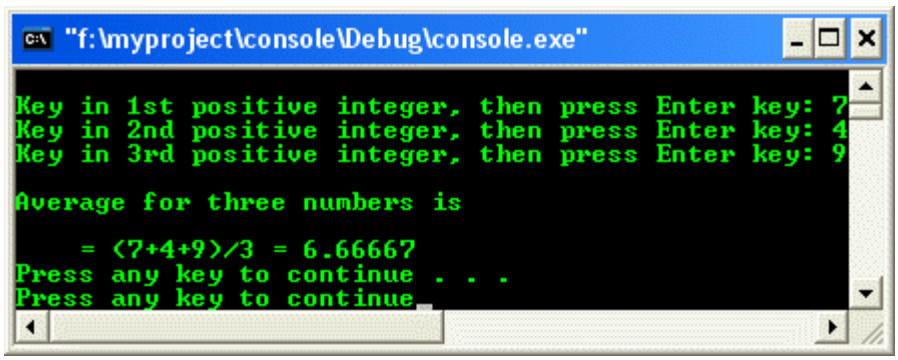


- Previous program example compiled using VC++/VC++ .Net. You can discard the `system("pause");` and its header file `<cstdlib>`.

```
 //Previous example compiled using
//VC++/VC++ .Net...using C header in C++
#include <iostream>
#include <cstdlib>
using namespace std;

int main(void)
{
float x, y, z;

//Display for user data on standard output, screen
cout<<"\nKey in 1st positive integer, then press Enter key: ";
//Read the data from standard input, keyboard
cin>>x;
cout<<"Key in 2nd positive integer, then press Enter key: ";
cin>>y;
cout<<"Key in 3rd positive integer, then press Enter key: ";
cin>>z;
cout<<"\nAverage for three numbers is \n";
cout<<"\n = ("<<x<<"+"<<y<<"+"<<z<<")/3 = "<<(x+y+z)/3<<"\n";
system("pause");
```

```
return 0;
}
```

Output:



- A programming language enforces a set of rules, symbols and special words used to construct a program.
- A set of rules that precisely state the validity of the instructions used to construct C/C++ program is called **syntax** or C/C++ grammar.
- The correctness of the instructions used to write C/C++ program is called **semantics**.
- These set of rules for instructions validity and correctness are monitored or guarded by the compilers.

1.6 The `main()` function

- According to the C/C++ standard, only two definitions of `main()` functions are portable:

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

- And

```
int main (int argc, char* argv[])
{
  return 0;
}
```

- Where:

`argc`	Is an **argument count** that is the number of command line arguments the program was invoked with.
`argv[]`	Is an **argument vector** that is a pointer to an array of character strings that contain the arguments, one per string.

- The following is a program example when you issue `echo` command at the command prompt.


```
//echo command-line arguments
//program example
#include <stdio.h>

int main(int argc, char *argv[])
{
   int x;
   for(x = 1; x < argc; x++)
        printf("%s%s", argv[x],(x<argc-1) ? " ": "");
```

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

- Note that the return type `int` is required because the implicit `int` is deprecated.
- You may, but are not a mandatory to end `main()` function with a `return` statement. Unlike C, for C++ the standard defines an implicit:

```
return 0;
```

- At the end of `main()` function. Remember that 0 is an integer.
- This means that every program that leaves `main()` function without a return statement is assumed successful, that mean returning integer 0 and any value other than 0 represents a failure.
- Note that some compilers might generate a warning or error message regarding this thing and some compiler may need to explicitly put the `void` if there is no return or empty return statement as shown below:

```
void main()
{...}
```

- Or something like this:

```
void main()
{
  return;
}
```

- The detail discussion of the `main()` and command line arguments is discussed in ModuleY and Module 8, section 8.9.
- Steps needed to create a Windows portable executable (PE) file for empty Win32 console mode application is explained HERE.
- The following example shows the compiling, linking and running a C program using **`gcc`**. For complete commands and examples for **`gcc`**, **`gdb`** and **`g++`** please refer to Module000. Other utility and **`gdb`** can be found in Module111.
- Whenever needed, program examples compiled using `gcc` and `g++` also included at the end of each Module of this tenouk.com Tutorial and for this Module is shown in the following example.

```
[bodo@bakawali ~]$ vi simath.c
/*Simple mathematics calculation-simath.c*/
//header files.
#include <stdio.h>
#include <stdlib.h>

//main() function.
int main( )
{
        //variables declaration
        int     x, y, z;

        //variables initialization
        //assign 20 to variable x.
        //or put the value of 20 in memory location labeled by x
        x = 20;
        y = 2;

        printf("Given x = 20, y = 2\n");
        printf("\nx / y = %d", x / y);
        //do some calculation
        x = x * y;
        y = y + y;
        printf("\nx = x * y");
        printf("\ny = y + y");
        printf("\nNew value for x / y = %d", x / y);
        z = 20 * y / x;
        printf("\nz = 20 * (y / x) = %d\n", z);
        return 0;
}

[bodo@bakawali ~]$ gcc simath.c -o simath
[bodo@bakawali ~]$ ./simath
Given x = 20, y = 2
```

```
x / y = 10
x = x * y
y = y + y
New value for x / y = 10
z = 20 * (y / x) = 2
```

- Quite a complete gcc (GNU Compiler Collection), gdb (GNU Debugger) and Gas (GNU assembler) commands and examples can be found in Module000 and Module111.

----------o0o----------

Further reading and digging:

1. Check the best selling C/C++ books at Amazon.com.
2. Get the latest C/C++ standards reference. You can download or read online the specifications at the following links. These links are very useful if you want the update information such as new features, obsolete items etc. ISO/IEC is covering ANSI and is more general.

    i. ISO/IEC 9899 (ISO/IEC 9899:1999) - C Programming language.
    ii. ISO/IEC 9945:2002 POSIX standard.
    iii. ISO/IEC 14882:1998 on the programming language C++.
    iv. ISO/IEC 9945:2003, The Single UNIX Specification, Version 3.
    v. Get the GNU C library information here.
    vi. Read online the GNU C library here.

3. For the use of the standard and non-standard header files with different compilers and mixing C and C++ codes and libraries, please refer to Module 23, mainly Section 23.3 and above. If you are a beginner, it is better for you to read this chunk first.