1. Introduction

- The course is an introductory and intermediate level course in numerical and computational methods in Physics.

- You will learn some Physics Simulations and Analysis via C++ and ROOT programs.
Computer programming is an essential part of the work of many scientists and engineers.

We will teach C++ Programming Language & ROOT which

- is not easy to learn (compared to Fortran)
- has a lot of technical programming details
- is good at system and hardware programming
- is mostly preferred by engineers and young programmers!
- is widely used in the software industry & HEP & NP

We will use Linux Operating System (Ubuntu Dist.)
2. Web Resources for the Course

- Course web page
  www.gantep.edu.tr/~bingul/ep578

- University of Gaziantep C++ resource page
  cpp.gantep.edu.tr

- C++ Resources Network:
  www.cplusplus.com

- C++ Reference:
  www.cppreference.com

- Türkçe ‘C Programlama Dili’ne Giriş’:
  www.gantep.edu.tr/~bingul/c

- ROOT – Object oriented Data Analysis Framework
  root.cern.ch

3. Course Content

- Introduction to Programming
- History of C++
- Structure and Basis of C++
- ROOT program
- Monte Carlo Methods
- Simulations of Physical Systems
e.g. Radiactive and particle decays, Cross-sections,
  Probability distributions, ...
4. Marking / Grading

- Homeworks  %70
- Final  %30

- 70  CC
- 75  CB
- 80  BB
- 85  BA
- 90+  AA

5. Computer


- A computer is a machine that manipulates data according to a set of instructions.

- First computers were developed in 1940–1945, they were very large in size.

- Modern computers are based on integrated circuits making them very fast and small in size.
6. Parts of a Digital Computer

A computer can be divided into two main parts:

- **Hardware (=Donanım):** electronic and mechanical parts.
  
  *Storage Units, Input Units, Output Units, Process Units*

- **Software (=Yazılım):** all programs running
  
  - Operating System (OS)
  - Compilers
  - Application Programs

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7. Linux Operating System

- Wikipedia says:

  “Linux is a computer operating system which is based on free and open source software. Although many different varieties of Linux exist, all are Unix-like and based on the Linux kernel, an operating system kernel created in 1992 by Linus Torvalds.”

- Linux can be installed on a wide variety of computer hardware, ranging from

  mobile phones, tablet computers, routers and video game consoles,

  to

  desktop/laptop computers, mainframes and supercomputers.
8. Ubuntu

- Wikipedia says:
  “Ubuntu is a computer operating system based on the Debian GNU/Linux distribution and distributed as free and open source software. It is named after the Southern African philosophy of Ubuntu (humanity towards others).”

- http://www.ubuntu.com
**Download**

- Go to: http://www.ubuntu.com/download
- Select Run it with Windows and run wubi.exe

**Install**

- After your computer restarts:
Uninstall

1. Re-run wubi.exe
2. click on Remove button

9. Computer Programming

See http://en.wikipedia.org/wiki/Computer_programming

Computer programming (coding) is the process of

- writing,
- Testing / debugging / troubleshooting
- maintaining

the source code of computer programs.

The source code is written in a programming language, e.g.

```cpp
// A simple C++ program
#include <iostream>

int main(){
    cout << "Hello World!\n";
    return 0;
}
```
10. What is C++?

See [http://en.wikipedia.org/wiki/C++]

- C++ (pronounced "C plus plus")
  - is a general-purpose and middle-level programming language
  - is an enhancement to C
  - was developed by Danish computer scientist **Bjarne Stroustrup** in 1979 (called C with Classes) at Bell Labs (named C++ in 1983)
  - was ratified in 1998 ISO/IEC 14882:1998

- Recently, a revised ISO C++ standard, known informally as **C++0x** has been produced.
  
  *You can find a recent talk given by him at CERN: [http://indico.cern.ch/conferenceDisplay.py?confId=67017]*
A First C++ Program

```cpp
// First C++ program
#include <iostream>
using namespace std;

int main()
{
    cout << "Hello World!";
    return 0;
}
```

Program source file name: hello.cpp

In general C++ files have extentsions: .cpp, .c++, .cxx, .cc

- **Line 1**: Lines starting with // are considered as comment.
- **Line 2**: Lines starting with # are directives for preprocessor
  #include <iostream> tells the compiler to include the
  iostream file containing declarations of basic input output.
- **Line 3**: All elements (variables, objects, ...) of C++ library declared
  in std namespace. cout is the part of std namespace.
- **Line 4**: An empty line does nothing but helps readability.
- **Line 5**: Actual program, program starts with main() function.
  Each C++ program must have only one main() function.
  The beginning and end of the main() block is indicated by braces { }.
- **Line 7**: Outputs "Hello World" to the user screen.
- **Line 9**: return statement terminates the function (here main program).
  return 0 sends a message to OS: "program ends without an error"
Compile and Run
We will use Dev-C++ compiler

Compile and Run
We use g++ command in a Terminal
A Second Program

// Calculates the sum of two integers
#include <iostream>
using namespace std;

int main() {
   int a, b, total;
   cout << "Enter two integers: ";
   cin >> a >> b;
   total = a + b;
   cout << "The sum is " << total << endl;
   return 0;
}

Enter two integers: 11 22
The sum is 33

Standard Input and Output (I/O)

- The standard C++ library includes the header file \texttt{iostream}, where the input and output stream objects are declared.
  
  - \texttt{cout} to output data to the \textit{screen}
  - \texttt{cin} to input data from the \textit{keyboard}.

- This specific file (\texttt{iostream}) can be found usually under the folder:

  for Linux (GCC): /usr/include/
  for Windows (Dev-C++): C:\Dev-Cpp\include\
### Standard Input and Output (I/O)

- **Basic Output**
  
  ```cpp
  cout << "Hello World!"; // Outputs Hello World!
  cout << "Hello " << "World!"; // Outputs Hello World!
  cout << 1453; // Outputs the number 1453
  cout << x; // Outputs the content of x
  ```

- **Line break on output**
  
  ```cpp
  cout << "University of "; // outputs:
  cout << "Gaziantep"; // University of
  cout << "University of\n "; // University of
  cout << "Gaziantep"; // Gaziantep
  ```

### Standard Input and Output (I/O)

- **Basic Input**
  
  ```cpp
  cin >> a; // reads variable a from keyboard
  cin >> a >> b; // reads variables a and b
  ```

### Calculates the sum of two integers

```cpp
#include <iostream>
using namespace std;

int main()
{
    int a, b, total;
    cout << "Enter two integers: ";
    cin >> a >> b;
    total = a + b;
    cout << "The sum is " << total << endl;
    return 0;
}
```
Standard Input and Output (I/O)

If you remove the line “using namespace std;” then the source code on the previous pages needs modifying as follows:

```cpp
// Calculates the sum of two integers
#include <iostream>

int main()
{
    int a, b, total;
    std::cout << "Enter two integers: ";
    std::cin >> a >> b;
    total = a + b;
    std::cout << "The sum is " << total << std::endl;
    return 0;
}
```

11. Homeworks 1

Solve the following problems. You have to prepare a pdf document and send it to me until next lecture. 
E-mail: bingul[at]gantep.edu.tr (replace [at] with @)

1. Write a program named `triangle.cpp` to input the base $b$ and height $h$ of a right-angle triangle, and output its area.

2. Write a program named `circle.cpp` to input the radius $r$ of a circle and output the circumference of the circle.

3. Write a program to input kinetic energy $K$ in MeV of a free electron (with mass $m_e = 0.511$ MeV/c$^2$) and outputs the momentum in MeV/c and de Broglie wavelength in nanometers of the electron. Use relativistic kinematics.